THE

FOUNDRY TRADE JOURNAL

WITH WHICH IS INCORPORATED

THE IRON AND STEEL TRADES JOURNAL

VOL. 54 Thursday, January 2, 1936 No. 1011

PUBLISHED WEEKLY

Subscription Terms: 15s. per annum.
Foreign and Colonial: 17s. 6d. per annum.
All Subscriptions are payable in advance.

All Communications to be addressed to the Editor, the Advertisement Manager, or the Publisher of

THE FOUNDRY TRADE JOURNAL,
49, WELLINGTON STREET, LONDON, W.C.2

Telegraphic Address: "Zacatecas, Rand, London."
Telephone: Temple Bar 3951 (5 lines).

THE FOUNDRY TRADE JOURNAL IS THE OFFICIAL ORGAN OF

The Institute of British Foundrymen
The Institute of Vitreous Enamellers
The National Ironfounding Employers' Federation
The Welsh Engineers' and Founders' Association
and
The Foundry Trades' Equipment and Supplies Association

Institute of British Foundrymen

PRESIDENT: 1935-36

J. E. Hurst, "Ashleigh," Trent Valley Road, Lichfield, Staffs.

LIST OF SECRETARIES—

General Secretary: T. Makemson, Saint John Street Chambers, Deansgate, Manchester. London Office: 49, Wellington Street, London, W.C.2.
Birmingham, Coventry and West Midlands: A. A. Timmins, A.I.C., 21-23, St. Paul's Square, Birmingham.
Sheffield: T. E. Walker, "The Priory," Oughtibridge, near Sheffield.
Scottish: J. Bell, 60, St. Enoch Square, Glasgow.
Lancashire: J. E. Cooke, 1, Derbyshire Crescent, Stretford, Manchester.
London: K. W. Lockwood, Stewarts and Lloyds, Limited, Winchester House, Old Broad Street, London, E.C.2.
Newcastle-upon-Tyne: W. Scott, Sir W. G. Armstrong, Whitworth & Company (Ironfounders), Limited, Close Works, Gateshead-on-Tyne.
East Midlands: B. Gale, "Parkdale," Boulton Lane, Alvaston, Derby.
West Riding of Yorkshire: S. W. Wise, 110, Pullan Avenue, Ecclesshill, Bradford.
Wales and Monmouth: J. J. McClelland, 122, Wellington Road, Bilston, Staffs.
Middlesbrough: D. Anderson, 147, Stockton Street, Middlesbrough.
Preston: P. Leyland, 6, Ashley Terrace, Farington, Lancs.
Lincoln: E. R. Walter, M.Sc., The Technical College, Lincoln.
Burnley: W. Haworth, 37, Westbourne Avenue, Burnley, Lancs.
Falkirk: R. McNair, "Braewick," Larbert Road, Bonnybridge, Scotland.

National Ironfounding Employers' Association

President: J. Smith, Smith & Company (South Shields), Limited, Nile Street, South Shields.
Secretary: Harold G. Judd, C.B.E., 8, Frederick's Place, E.C.2.

The Institute of Vitreous Enamellers

President: Dr. J. W. Mellor, F.R.S., Sandon House, Regent Street, Stoke-on-Trent.
Chairman: W. E. Whittle, W. E. Whittle, Limited, Eccles, near Manchester.
Hon. Secretary: Miss E. Christine Elliot, 49, Wellington Street, Strand, London, W.C.2.

Foundry Trades' Equipment and Supplies Association

President: G. T. Lunt, "Briardene," Newbridge Avenue, Wolverhampton.
Secretary: K. W. Bridges, Grand Buildings, Trafalgar Square, London, W.C.2.

Welsh Engineers' and Founders' Association

President: W. E. Clement, Morfa Foundry, New Dock, Llanelly.
Secretariat: 2, Royal Metal Exchange, Swansea.

BRITISH CAST IRON RESEARCH ASSOCIATION

The Registered Office and Laboratories of the B.C.I.R.A. are:—
21-23, ST. PAUL'S SQUARE, BIRMINGHAM
Telephone: Central 1885. *Telegrams: CIRA*

The B.C.I.R.A. Scottish Laboratories are:—
Foundry Technical Institute, Meek's Road, Falkirk
Telephone: 332

Contents

	PAGE.
Examiners Examined	1
Industrial Research	1
Correspondence	2
Publication Received	2
The Slump in Lead	2
A Comparison of Some Melting Furnaces in a Grey-Iron Foundry	3
L.M.S. Railway Contracts	6
Vitreous Enamelling Section—	
The Preparation of Iron Castings for Vitreous Enamelling by Sand Blasting	7
Heat-Resisting Alloys	10
Continuous Pouring of Ford Cylinder Blocks	12
Production of Centrifugal Grey-Iron Castings in Water-Cooled Moulds	13
French Exchange Paper	14
This Week's News in Brief	16
Trade Talk	16
New Company	16
Personal	16
Obituary	16
Contracts Open	16
Forthcoming Events	16
Raw Material Markets	18

Examiners Examined

A few weeks ago a little book was published under the title "An Examination of Examinations," and its perusal suggests that examiners as a body have failed to pass the test of examination. The fact that the inquiry largely resulted from examiners themselves must be accounted in their favour, but they must be astonished to see the magnitude of the element of chance in their results. It is common knowledge that employers are attaching more and more importance to examination results (and local and national government services and the professions have always attached the highest importance to them). Employers do this not because they have any particular faith in the examination itself or in many cases interest in the subjects examined, but because they have no other criterion by which they can judge the intelligence of candidates, and if examinations have been taken they can concentrate on appearance, bearing, integrity of character, health and other matters in which they may be concerned. And it must be admitted that although examinations tend to test a candidate's knowledge rather than his capacity, on the whole they do act as a rough guide, because it is a fair assumption that a candidate who has had the opportunity to acquire knowledge will, if he be industrious, in fact have acquired it, assuming the ability to do so to be there. We have, however, tended to assume that a candidate who has failed is incapable of passing, and *vice versa*, whereas the above report indicates that this is by no means the case, and we do not doubt that examiners will take the results to heart. Our own experience of examinations indicates that examiners are careful. In other words, they endeavour to pass rather than to fail a candidate. There are certain severe professional examinations in which only a proportion of the candidates are passed, in which case the problem is not to see how many reach a predetermined standard, but to pick the best out of those who offer themselves for examination. But in the ordinary examination, particularly where failure may seriously discourage a candidate from pursuing his studies or where it may harmfully affect his career, our experience is that the magnanimity of the examiner offsets the accident which may result in a candidate's marks being below pass standard. The whole question is important enough for employers to appreciate just how far an examination result may be uncertain or unjust, and we propose to give a few instances from the book mentioned in a later issue.

Industrial Research

It is now essential for every foundry concern to purchase each year the "Summary of the Report of the Department of Scientific and Industrial Research," for it discloses developments which no go-ahead concern can afford to neglect. It costs three shillings, and is published by H.M. Stationery Office, Adastral House, Kingsway, London, W.C.2. Obviously, foundry executives are well aware of the work carried out by the British Cast Iron Research Association, one of eighteen bodies supported financially by the Association. The British Broadcasting Company, in dealing with the Report, said that British industry was becoming more "research minded," a rather slangy method of saying that they were becoming more appreciative of research. This is supported by the Report, as most of the associations have substantially increased their incomes. We substantiate our opening statement as to the necessity for studying this report, because the majority of foundries work for some other industry, and in general such developments react on their requirements for machinery. Moreover, one learns that the National Physical Laboratory is attempting to devise a formula from which the best lighting for any industrial occupation can be deduced. This is obviously a factor of vital importance to every foundry. Vitreous enamellers will be interested to learn that investigations are being made to find the best "artificial daylight" lamp for colour matching, whilst many foundries using pulverised fuel will want to know more about an apparatus which has been devised for distributing the powdered coal equally between two or more furnaces. Pipe founders are informed as to certain bacteria which cause corrosion of their castings when laid in clay soil, whilst metallurgists will be interested to follow the production of the rare metals, germanium and gallium, from coal ash and flue dust. Finally, an industrial respirator has been designed, and is undergoing practical tests, which provides satisfactory protection against harmful industrial dusts and allows a maximum range of vision to the worker. These developments are supplemented by notes from the associations which contain pointers of industrial significance to the foundry industry.

Correspondence

[We accept no responsibility for the statements made or the opinions expressed by our correspondents.]

Some Properties of Mould and Core Materials at Elevated Temperatures

To the Editor of THE FOUNDRY TRADE JOURNAL.

SIR,—I note Mr. Hudson's remarks in your correspondence column. Dietert's machine for testing greenstrength has doubtless been available for a long time. The design under consideration was, however, taken more from the principle of the hydraulic press after considering other methods of load application such as gearing and the beam. Mr. Hudson had a drawing, and turning the machine on end and lengthening bolts does not introduce sufficient novelty to warrant lack of acknowledgment.

To-day, Mr. Dietert's Paper comes to hand (A.F.A., Vol. VI, No. 6, December, 1935) in which he has given some work on expansion and mould hardness. He says, "Expansion is proportional to mould hardness." "The above fact explains why moulders remedy casting defects caused by mould wall failures by *reducing the ramming*." I would again urge Mr. Hudson to complete this section of the work and give results instead of assuming similarity between sand and firebricks.

Regarding "Fritting" I do not think I have misunderstood Mr. Hudson and, in the case of the greensand and drysand referred to, the greensand is weak rather than strong. Perhaps Mr. Hudson can supply samples of "fritted" sand from his foundry practice. I shall be very interested in them.—Yours, etc.,

WM. Y. BUCHANAN.
John Lang & Sons,
December 27, 1935. Johnstone.

British Trade in the Near East

To the Editor of THE FOUNDRY TRADE JOURNAL.

SIR,—May we draw the attention of your readers to the great and increasing opportunities this year for British trade in the Near East through the regeneration of Palestine and the surrounding territory?

The development of this part of the world has been one of the few bright features during the recent years of depression abroad. Since 1931 the imports of Palestine alone have increased nearly threefold. In 1931 they amounted to £5,940,000. In 1934 they totalled £15,153,000, whilst for this year, if the annual figures bear out the promise of the half-yearly ones, Palestine's imports will be £17,000,000 or more.

Moreover, as anyone who has recently visited Palestine is aware, building and agricultural development is proceeding at a prodigious pace, and there is consequently a steady and increasing demand for machinery, building materials, etc.

British manufacturers are sharing in this development, but they are not sharing to the extent they should—and would, if they took a more active interest in this important market. For instance, during the half-year ending June 30, 1935, British exports to Palestine amounted to only £1,108,842 out of a total purchase by Palestine of £8,475,000.

An opportunity for British trade to obtain a better share of this expanding market is offered by the Levant Fair, which is to be held at Tel-Aviv, in Palestine, in May this year. There is a British Pavilion at this Fair, and arrangements have been made in Palestine for the formation of a British Exhibitors' Committee, which will attend to all matters in connection therewith. The Federation of British Industries and the Department of Overseas Trade are also taking a friendly interest.

These efforts, however, will be of little avail unless British manufacturers themselves begin to take action in the matter before it is too late. Recent news indicates that many European countries are waking up to the gold mine available to traders in this rapidly-expanding market, and it is therefore essential that our manufacturers and exporters should take early and practical advantage of the tendency which still obtains in Palestine to give first preference to the British-made article if no Palestinian one is available.—Yours, etc.,

R. H. MORGAN,
H. A. PROCTER,
W. F. STRICKLAND,
TOM WILLIAMS.

House of Commons.
January 1, 1936.

Publication Received

The Year Book of the French Foundrymen's Association. Published by the Association from 44, rue de Rennes, Paris VI.

This yearly publication, which contains, *inter alia*, the rules and regulations of the Association, its officers, membership list and details of the annual competition, has this year been thoroughly revised and now includes sections dealing with melting furnaces, moulding, patternmaking; the standard specifications issued by the French railway companies; tables of formulæ; accident prevention and workmen's insurance. This year-book is unquestionably useful, but its utility could be enhanced by a more drastic sub-editing, as we find here and there a certain amount of verbiage. The specifications, for instance, could be usefully printed in abstract, by eliminating the commercial clauses. We find the section dealing with accident prevention extremely good, as the subject gains much by the application of a modicum of Latin logic.

After giving some general advice as to how to avoid falls, cuts, burns, fire and accidents from compressed air and electricity, each type of workman—such as lorry drivers, teamers, knockers-out, fettlers, electricians, stove minders, cupolamen, the maintenance gang, grinders, patternmakers, moulders, coremakers, yard labourers, sand-preparing men, sand blasters and inspectors—are each individually accorded their instructions or code. This individual treatment, although it means endless repetition of similar instructions, by its particularised appeal makes the result more telling.

We are not too sure as to the wisdom of including notes about insurance, because, from the British angle, this is a matter for the employers' associations to deal with.

An Electric Steel Foundry for New Zealand.—The establishing in Christchurch, New Zealand, of an electric steel foundry, with a capital of approximately £20,000, is forecast by negotiations which have been proceeding between Australian Alloy Steel, Limited, and the New Zealand Electric Steel Company, Limited. It has been stated unofficially that the Australian firm's offer of approximately £14,000 for the purchase of the Christchurch firm's works at Sockburn has been accepted. The offer was considered at a meeting of shareholders recently. The precise part to be played by the Australian firm in the development of the steel-casting industry here is not yet known, and it is understood that large Christchurch engineering firms have been involved in the negotiations. Mr. J. M. Deschamps, managing director of Australian Alloy Steel, visited Christchurch some weeks ago to make investigations, but there was for a time some difficulty in arranging for the purchase of the Sockburn works, a necessary part of the plan. The Sockburn works at present employ about 20 men. Under the new company it is hoped to extend the plant, permitting the manufacture of extensive steel castings which are now being imported from abroad. It is expected that the new company will begin operations early in the New Year. Mr. Deschamps, from whom the first proposal came to develop the electric steel industry in New Zealand, introduced the electric-furnace process in Australia in 1916. Since then his firm has supplied more than 40,000 tons of special steel to Commonwealth industries and to Government departments.

The Slump in Lead

BY "ONLOOKER."

The experienced dealer in metals is always on the lookout for changes in sentiment, and, as far as possible, he tries to keep himself in the position of one to whom the changing winds of circumstance can blow neither well nor ill. There are occasions, however, when it seems reasonable to hold a certain amount of metal at risk owing to apparent innate strength in the position, or because a production programme dictates that purchases should be in excess of sales, and should a break occur in the market at this juncture, the results may well be serious. There is much to recommend the maintenance of a level book as far as non-ferrous metals are concerned, for, however well intentioned is the advice we receive, only too often there proves to be something waiting round the corner which upsets our calculations and promotes a wave of selling, the results of which are disastrous for those holding metal at risk.

Not for a long time has there been such a sudden and unexpected reversal in sentiment as has occurred in lead during the past few weeks, for from a state of affairs embracing the belief that at £18 this metal was almost certain to appreciate to £20 there has been a disastrous setback, which at the time of writing has brought the quotation within measurable distance of £15. During the uprush in values which followed the outbreak of hostilities in Northern Africa, business was done at £20, or even higher, but the official market quotation did not climb above £19 10s., so there was some reason to expect that a turn would take place at £18, for on all sides it was agreed that consumption was good, supplies far from excessive and the prospects for 1936 excellent. Bonded stocks in this country, *i.e.*, reserves of foreign metal, were heavily drawn upon last year, a fact which pointed to a lag between production and consumption, and suggested that the end of the rise had not been seen. During the first few weeks of the last quarter of 1935 the "bulls" of lead were definitely in the ascendant, but to-day they are a motley and despondent herd!

What has gone wrong and where have calculations come adrift from the hopeful anchorage to which they seemed to be so securely united only a short time ago? At first it seemed reasonable to blame the upset in silver, but since a fall in the quotation of this metal must in the long run prove to be a bull point for lead, a reaction due to this cause should not have gone very far. Have bears attacked the market? Latterly perhaps, and before this comment on the situation appears, covering by operators for the fall may have stopped the rot and turned the rout into a rally, for, with no curtailment pact in existence, the position of lead is inherently a strong one. External factors have, of course, undermined confidence generally, and intimation that Australia contemplates an increase in production this year has given bulls food for serious thought, but the real trouble seems to lie in the fact that the price was advanced too far for safety through the discounting in advance of favourable factors which have not matured.

Looking back to the early part of last year, it is realised that the quotation for lead appreciated by about 100 per cent., and that, even though at £11 it was difficult for producers to secure profits, a price of practically double as much brought them a rich reward. It must be obvious, therefore, that around £15 or £16 lead interests have nothing to grumble about, and it seems likely that no curtailment in output is likely on account of the price level. However, the prospects for lead consumption are such that £15 sounds rather too low, and the early months of 1936 ought to see a better level.

A Comparison of Some Melting Furnaces in a Grey-Iron Foundry*

By T. R. TWIGGER

Introductory

This Paper does not profess to be a complete guide to melting furnaces in a grey-iron foundry—its main purpose is to bring out points of comparison which appear to be of some importance. In addition it includes a more detailed reference to some newer types of furnace, with which the author has been intimately connected in two separate foundry departments, one operating continuously on centrifugal castings for piston rings, cylinder liners, brake drums and valve seat inserts, and the other operating on a non-continuous basis for a variety of sand castings.

Choice of Furnace for Grey-Iron Melting

Apart altogether from economical considerations the choice of a melting unit appears to depend largely upon:—(1) Whether the quality of metal required, or the temperature requirements are such that certain melting furnaces are particularly suitable; (2) whether or not a continuous supply of molten metal is required over several hours or a complete working day, and (3) whether or not a large variety of different mixtures is required in relatively small quantities.

In some instances the above considerations may outweigh the extra operating cost of a particular melting process. It is obvious however that for any particular furnace steps should be taken to see that the operating conditions are on the most economical basis for that type of furnace.

Sources of Heat

Coal.—On account of its abundance and the immensity of the reserves coal still remains the prime source of heat in this country. It has however been little used in its raw state—except to a small extent for air furnace melting, a method but little practised except for roll making in grey-iron foundries. Coal has, however, recently come into use on a considerable scale with the adoption of pulverised fuel furnaces of the Brackelsberg and Sesci types. Coal in the form of coke (cupola and crucible furnaces), gas (crucible furnaces), and electricity (arc and induction furnaces) still represents by far the greater proportion of the heat units generated in melting grey iron.

Oil.—Oil, the advantage of which is its controllability, is now a competitor, being used for crucible furnaces, and to an increasing extent at the present time for rotary and other types of melting furnace. There being little or no oil found in this country, and supplies of oil from coal being at present very limited, metallurgists are dependent upon external sources of supply. The position of doubt brought in by the introduction of a tax on fuel oil appears to have been clarified by the fact of the tax not being further increased on oil used for industrial purposes.

An interesting comparison of the cost of heat units in various fuels was given by T. F. Unwin[1] and is here reproduced.

In conjunction with the description shown on Table I there is of course another factor which enters into final costs and that is the thermal efficiency of the furnace. The author's opinion is that so far as grey-iron melting is concerned the desired efficiency can in general only be obtained with a furnace of either rocking or completely rotating types—with, in the case of combustion furnaces, the maximum recuperation of the waste heat.

Basis of Melting Costs

In comparing the costs of melting by various furnaces, some clearly-defined method of determining the melting cost per lb. of metal delivered is obviously necessary. Attention has recently been given to this matter by the Institute's Costing Sub-Committee.[2]

In the author's opinion, it is necessary in a foundry using several types of melting furnace that a separate melting cost should be determined for each particular furnace. In the works with which the author is connected a comparison of melting costs from different furnaces has been made during the past two years on the basis of the following items:—(*a*) Power; (*b*) fuel; (*c*) labour; (*d*) refractories; (*e*) depreciation; (*f*) repairs and maintenance; and (*g*) metal lost in melting. It will be noticed that these

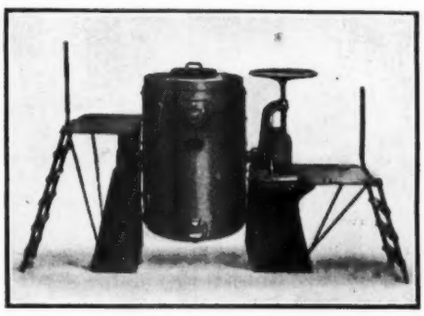


FIG. 1.—MORGAN OIL-FIRED CRUCIBLE FURNACE (CENTRAL-AXIS TYPE).

items follow closely the basis recommended by the Institute's Costing Sub-Committee. With regard to labour costs, it is fairly clear that the appropriate overhead charge should be added, although in cases where the overheads normally contain some of all the items given above, the overhead charges in arriving at the melting cost will be correspondingly reduced. It is considered better to determine the cost of molten metal delivered by the melting unit making no allowance for the yield of good castings, due allowance for this being made in the final cost figure, which will, of course, include moulding, core-making, finishing, etc., in addition to melting.

TABLE I.

Fuel.	Calorific value.	Cost per therm (100,000 B.T.U.)	B.T.U. for 1d.	Calculated at
Electricity	3,413 B.T.U. per unit	14.65d.	6,826	½d. per unit.
Town gas	500 B.T.U. per cub. ft.	4.8d.	20,833	2s. per 1,000 cub. ft.
Fuel oil	19,000 B.T.U. per lb.	1.83d.	54,500	65s. per ton.
Producer gas	150 B.T.U. per cub. ft.	2d.	50,000	3d. per 1,000 cub. ft.
Coke oven gas	500 ,, ,, ,,	1.8d.	55,500	9s. ,, ,,
Coke	11,000 B.T.U. per lb.	1.46d.	68,400	30s. per ton.
Coal	13,500 ,, ,,	0.79d.	126,000	20s. ,,

It is obvious that melting costs depend very largely on the prevalent conditions—type of work, etc.—in various foundries; therefore, it is seldom satisfactory to compare the figures obtained in one foundry with those from another. It is, however, possible for any particular foundry using various types of melting furnace to obtain a fairly accurate comparison between the various units on the basis of the methods suggested above.

A comparison of some melting costs for various furnaces was given in a Paper[3] by J. E. Hurst a few years ago. These figures were obtained in a Continental works, and do not, of course, include the cost of the material.

Total Melting Costs for 1 *Ton of Material.*

	£ per ton.
Crucible furnace	3.564
Cupola furnace	0.74
Oil furnace	1.86
Brackelsberg furnace	0.78
Electric furnace	2.6

Cupolas

No attempt is here made to describe the working of this furnace, which has so long been recognised as the standard melting unit for grey cast iron. In spite of its relatively low thermal efficiency, it is usually considered the cheapest melting unit in general use. There is little doubt that in many instances the cheapness of melting and the general convenience of operation have been the cause of lack of attention being paid to the obtaining of maximum efficiency. Under conditions of strict control the cupola can be made to give over a period of many hours a supply of hot, clean metal of good consistency as regards composition, although frequently some slight changes may be necessary in the charges at various times in the day to offset variation in composition (especially in total carbon) which may occur according to the height of the bed in the cupola. This may especially happen at the commencement of a long blow, using a high coke bed in which case a quantity of steel is frequently added to the early charges.

Considerable attention has recently been focused on the subject of carbon pick-up. Results of actual tests were published in the report[4] of the Cast Iron Sub-Committee of the Institute presented to the annual conference in 1934. Personal experience has been that the quality of the coke has a considerable bearing on the percentage of total carbon in the iron. Softer coke of the South Wales type gives an iron of maximum temperature, but there is a tendency to obtain distinctly high total carbon. Coke of the Durham type, on the other hand, which is usually harder and somewhat higher in sulphur, tends to give lower total carbon. In the author's experience, two types of coke are used; the proportions of these are usually kept the same, but they are sometimes varied as special conditions arise. In connection with the development of cupola practice, devices for ensuring a constant weight of air supplied to the cupola are becoming more common, especially in America.

The balanced-blast type of cupola as developed by the British Cast Iron Research Association appears to be gaining favour, 95 cupolas now having been converted or built for this type of working. Claims are made for greater economy of operation, and this, in spite of the higher bed which is necessary. It is claimed that 40 per cent. of the bed coke is recovered in good condition. Experience on the operation of balanced-blast cupolas will be found in a Paper by H. Shepherd.[5]

* A Paper read before the East Midlands Branch of the Institute of British Foundrymen, Mr. J. F. Driver presiding.

[1] FOUNDRY TRADE JOURNAL, November 17, 1932.

[2] FOUNDRY TRADE JOURNAL, November 8, 1934.

[3] J. E. Hurst. "The Cupola Furnace." FOUNDRY TRADE JOURNAL, November 19, 1931.

[4] FOUNDRY TRADE JOURNAL, June 28, 1934, page 407.

[5] I.B.F. Volume 26. Page 348.

The author has no personal experience on balanced-blast cupolas, as his firm's cupolas are of the type which is more difficult to convert, and, owing to the restricted space between the foundry wall and the cupolas, the latter would have to be moved to another position.

The great disadvantage to which any cupola appears to be subject is the great difficulty of accurately separating charges of different composition. Some interesting experiments in this direction were recorded by P. A. Russell* in a Paper presented to the London and East Midland Branches last year.

The writer's experience in trying to separate metal charges in the cupola has been definitely unsatisfactory, particularly when the charges have been fairly high in alloy additions; for example, charges of iron containing 1 to 1½ per cent. nickel and 0.3 to 0.5 per cent. chromium have shown less than half this amount when tapped from the cupola at the precise time which the alloy iron should have appeared. In the case of charges containing a large percentage of steel, there is often a considerable variation in the composition of successive tappings from a cupola, particularly if the latter is small.

When melting charges of austenitic iron it has frequently occurred that not only has the supposed austenitic iron as tapped from the cupola had to be scrapped, but a considerable amount of the following material as well, owing to the high alloy additions which are found in the succeeding charge. Should it be necessary to melt a charge of austenitic iron during a day's run it is found better completely to "blow down" the cupola and add a fresh bed of coke before melting the charge of austenitic iron, but other methods of melting austenitic iron are now more common. In the case of the centrifugal foundry a charge of special mixture is sometimes run at the commencement of a blow, this special charge being separated from the standard mixture which follows by an extra charge of coke. With considerable care a high degree of accuracy is maintained, but generally the metal tapped immediately following the special charge is used for heating the centrifugal moulds.

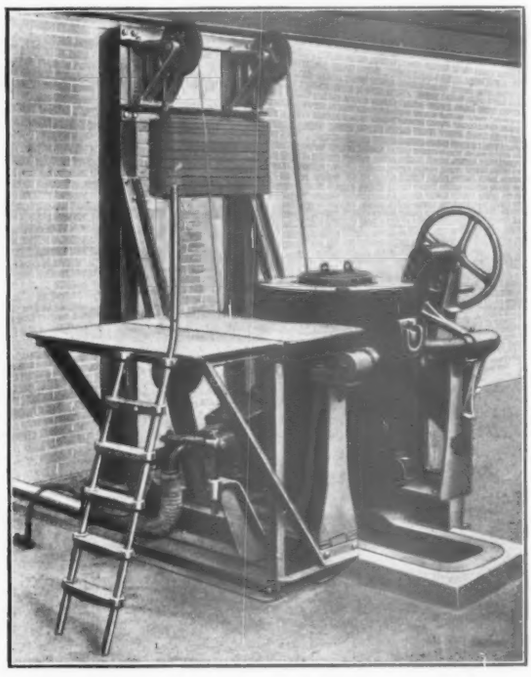


FIG. 2.—MORGAN OIL-FIRED CRUCIBLE FURNACE (LIP-AXIS TYPE).

Rotary Pulverised Coal-Fired Furnaces

The author has no personal experience of the Brackelsberg or Sesci types of furnace, although both have been considered in relation to the foundry with which he is connected. The amount of pulverising and storage plant required, with its consequently large demand on floor space, also the high initial cost, appear to render its use of doubtful economy in the case of small installations. In the case of foundries melting large quantities of special grey iron or refined pig-iron, these furnaces appear to be capable of utilising cheap raw material to produce high-quality material at an economic cost. It is understood that in these types of furnaces the melting losses are always relatively low. Considerable trouble was anticipated in connection with the refractory linings, but information to hand is that a furnace of the Sesci type using a rammed lining of French material (mixture containing 6 per cent. moisture as rammed) gives, with a certain amount of patching during its working life, a total of from 200 to 240 heats on a 10-ton furnace and from 100 to 140 on a 2-ton furnace. This is for iron relatively low in carbon, which renders the operating conditions more severe. Also, the metal is frequently held for some time on account of adjustments of composition. It is considered that for normal types of grey cast iron the lining life should be in the region of 300 heats for the 10-ton furnace and 200 heats for the 2-ton furnace.

Crucible Furnaces

In spite of the relatively high cost of melting in these units, due to the indirect transmission of heat and also to the fact that it is difficult to melt and superheat iron in less than about 3 or 3½ hrs., these furnaces are used to the author's knowledge in some instances where the iron is of a very special nature. They have the advantage of exact control of metal composition due to the absence of oxidation.

The oil-fired crucible furnace appears to score over the coke-fired unit for grey-iron melting on account of the greater certainty with which the desired high temperature can be obtained and the greater convenience in operation. These furnaces (typical modern examples of which are illustrated in Figs. 1 and 2) may be either of the lip-pouring or central-axis type. The lip-pouring type is naturally more expensive—but is of advantage in some instances, although in a grey-iron foundry provision can usually be made for withdrawing the metal on different levels, as, of course, happens with the central-axis type furnace.

In the British Piston Ring Company's foundry, oil-fired crucible furnaces are not used for melting except in very rare cases, but they have proved extremely useful in holding metal for use as required over a period of several hours. They frequently enable a special charge of metal to be melted in the cupola at the commencement of a blow and stored, thus furnishing a supply of molten metal which may be sufficient to operate one or more centrifugal casting machines, which run continuously for several hours on end. A method frequently practised is to melt a special charge, transfer it to the crucible furnace, and then use a percentage of the crucible-stored mixture with a percentage of standard cupola metal.

Under such conditions crucible life is normally approximately 120 hrs. for standard Salamander crucibles, but shorter life is, however, likely to be experienced if metal high in nickel or chromium is stored in the crucible.

Rotary Oil-Fired Furnaces

A furnace of the Stein type, having a nominal capacity of 1 ton, is installed for use in the sand-casting foundry, which is not operated on continuous lines (Figs. 3 and 4). Obviously, one rotary furnace could not operate in a continuous casting foundry, unless used for duplexing on the principle of constant addition and withdrawal of molten metal. This furnace was installed largely on account of the difficulty of separating mixtures of different composition in the cupola. As will be seen from the illustrations, the furnace consists of a cylindrical shell having a special oil burner at one end with an exit at the other end for the products of combustion, which are conducted by a hood and elbow to underground flues, from which they pass into the recuperator. The latter consists of a brickwork chamber containing a series of "U"-shaped tubes through which cold air from the fan is blown, to be heated by passage through the tubes and then conveyed through the insulated pipe to the burner. When first starting the furnace, all the products of combustion go through the recuperator, but, should the temperature in the flue at the bottom of the recuperator rise above 900 deg. C., it is necessary to open the bypass flue so that some of the heat goes to the stack. It may also be necessary to close the flues leading from the recuperator.

In the case of the plant with which the author is connected, difficulty was at first experienced due to the fact that the temperature at the base of the recuperator quickly rose to 1,000 deg. C., necessitating restriction in the flow of heat through the recuperator, under which conditions the air preheat was considerably lower than it should have been. This is attributed to the fact that, as water was found at flue foundation level, waterproof concrete was used for the flues, and this has an insulating effect. The difficulty has now been eliminated by the use of an injector system, which uses a small jet of air from the fan to introduce a considerable volume of atmospheric air into the flue. By this means the recuperator temperature is restricted somewhat, but an air preheat of up to 300 deg. C. is obtained.

Owing to a certain amount of difficulty with the furnace charging door, which is normally opened for charging and kept closed during melting, the door was removed, and the furnace is now charged direct through a hole, 11-in. dia., in the charging end.

Furnace Linings

The lining life presented one of the largest unknown factors in the choice of this furnace.

* "Experience in the Manufacture of High Grade and Alloy Cast Iron." FOUNDRY TRADE JOURNAL, December 6, 1934.

It can be stated, however, that the present lining life is satisfactory, using British refractories. The lining, which is originally 10 in. thick, is worn down to about 2½ in. thick before renewing. At the present time the practice is to chip back the remaining lining material and renew the lining by pneumatic hammer ramming with new refractory (the moisture content of which is carefully controlled at 6 per cent.). To renew a worn lining takes about 3½ tons of refractory, and this normally lasts about 120 heats.

Recuperator Life

After 14 months of operation, leakage was experienced in the recuperator, due to the screwed joints at the bottom of the tubes having failed; the remainder of the tubes are, however, in satisfactory condition.

Fuel Consumption

The fuel used is heavy fuel oil, averaging 0.92 specific gravity. It is pumped from the main storage tank into a service tank, which maintains a constant pressure to the burners. Electric heaters are provided in the service tank and also in the supply line to the burner. The fuel consumption over three heats per day averages about 18 to 20 per cent. by weight of the total weight of metal charged. This is for metal required to have a high degree of superheat as tapped from the furnace.

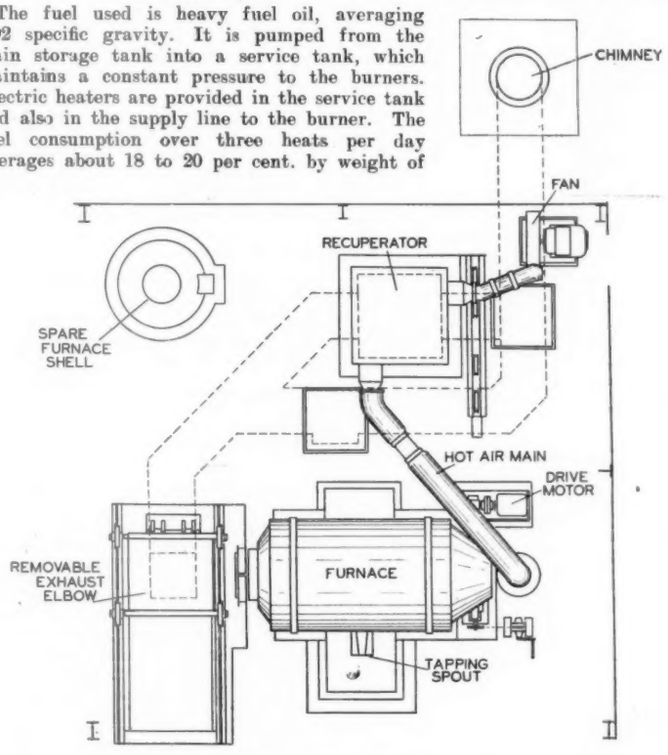


FIG. 3.—PLAN OF STEIN OIL-FIRED ROTARY-FURNACE INSTALLATION.

Melting Losses

These are usually in relation to the length of time the charge is in the furnace; consequently the first heat, which normally takes 2¼ hrs., shows melting losses of approximately 0.5 per cent. carbon and 0.4 per cent. silicon; for subsequent heats the losses are reduced to 0.3 per cent. carbon and 0.3 per cent. silicon. This is for charges containing a considerable amount of small chippings (obtained from the fettling department of the centrifugal foundry). The losses are always considerably higher when using fine scrap. Finely-crushed gas coke is used to offset some of the reduction in carbon, but this should not be added to the extent of more than 2 cwts. per ton, this amount being sufficient to offset a loss of about 0.3 per cent. in the carbon content. Crushed petroleum coke has been used, but this does not appear to have any advantage over gas coke in minimising carbon losses. With the use of borings, the losses are very much higher, and charges of all borings do not appear justified, even when using a considerable amount of crushed coke. Incidentally, the charge has 60 lbs. of limestone added per ton to take care of oxidation products.

Economic Considerations

To give the maximum efficiency with regard to fuel consumption, the furnace should be kept in regular use, melting not less than three heats per days (preferably four), in which case the first heat is charged overnight; this considerably minimises the preheat period. It is obviously inadvisable and uneconomical to hold the heat of metal in the furnace for any length of time while tapping. Careful records of cost obtained over a considerable period indicate that, provided the number of heats is not less than three per day, the melting costs are approximately similar to those of cupola-melted metal of the same quality, but this is only true when the charge for the Stein furnace contains low saleable value scrap and low-price pig-iron, as compared with the use of higher-priced pig-iron or refined iron in the cupola.

Electric Furnaces

The direct-arc furnaces, as commonly used for the melting of steel, appear to be very little used in this country for cast iron. In America the "Lectromelt" direct-arc furnace is used on a considerable scale, together with the Detroit rocking indirect-arc furnace. The writer's experience extends solely to two furnaces of the latter type (50- and 350-lb. cold-melting capacity). The latter will be seen in Fig. 5. It is the L.F.A.-type furnace of 350 lbs. cold charge or 500 lbs. molten capacity. The furnace consists of a cylindrical shell lined with suitable refractory, the electrodes entering through suitable refractory sleeves on the axis of the furnace. On the small 50-lb. cold capacity furnace an ingenious rocking mechanism is employed, by means of which the angle of rock, which, of course, is very small, soon after charging cold metal, automatically increases to the maximum rock by the time the charge is melted, the principle being that much heat is transferred direct from the lining to the metal charge. In the case of the larger types of furnace, automatic rocking has not yet been developed, the angle of rock being gradually increased by variable stops controlling the angle of rock. Automatic electrode control has not been applied to the smaller types of furnace, as the advantage does not appear to outweigh the extra cost. Such mechanism could no doubt profitably be applied to the larger sizes of furnace. There appears to have been reluctance on the part of some electricity-supply authorities to permit single-phase operation, which is required with the horizontal arc furnace, from the multi-phase supply. It is understood that these objections are now being withdrawn. This has a considerable bearing on the development of this type of furnace, as a very costly transformer equipment is needed should single-phase current be desired from a multi-phase supply. Where there are a number of furnaces, individual units can be wired across separate phases. In the case of the furnaces with which the author is familiar, no objection has been raised to single-phase operation, and current is supplied at normal bulk-supply tariff, this rate applying provided the furnaces are not used between 4.15 and 5.45 p.m. during November, December, January and February. It is understood that other power corporations in the country have granted special concessions, which indicates a commendable desire to extend the use of electric power for industrial purposes.

Current Consumption

In melting charges of grey cast iron in the L.F.A. type of furnace, the current consumption averages 650 kw.-hrs. per ton. This is for good melting conditions, where charges follow one another in quick succession, and this consumption is considered satisfactory for a small furnace. When duplexing charges, the current consumption naturally varies with the amount of solid material added and the degree of superheat desired.

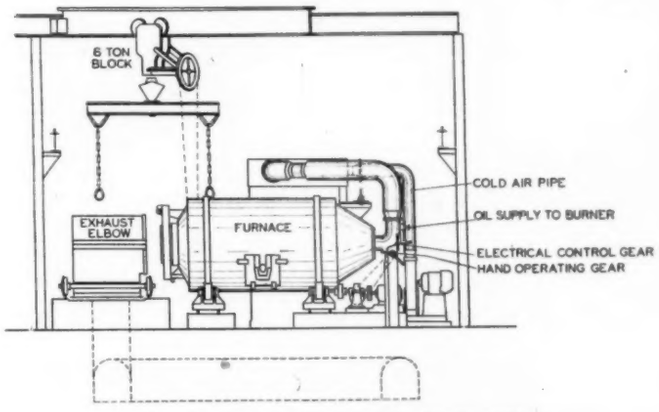


FIG. 3A.—ELEVATION OF THE STEIN ROTARY OIL-FIRED FURNACE.

TABLE II.—*Electric Furnace Losses.*
Cast U.59.

	Fracture.	T.C., per cent.	Si, per cent.	Rockwell hardness value.
As charged into furnace	Grey	3.38	2.03	C.19
After 1 hr. in furnace	,,	3.36	1.95	—
After 2 hrs. in furnace	,,	3.28	1.89	C.20
After 3 hrs. in furnace	,,	3.34	1.81	—
After 4 hrs. in furnace	Mottled	3.20	1.72	C.25

Melting Losses

One of the principal advantages of the rocking-arc furnaces is the close control which can

be maintained over metal composition. The losses of carbon and silicon are extremely low, being virtually negligible except when the metal is held any length of time in the furnace. An example of the losses of carbon, silicon and manganese after 4 hrs. in the furnace is given in Table II.

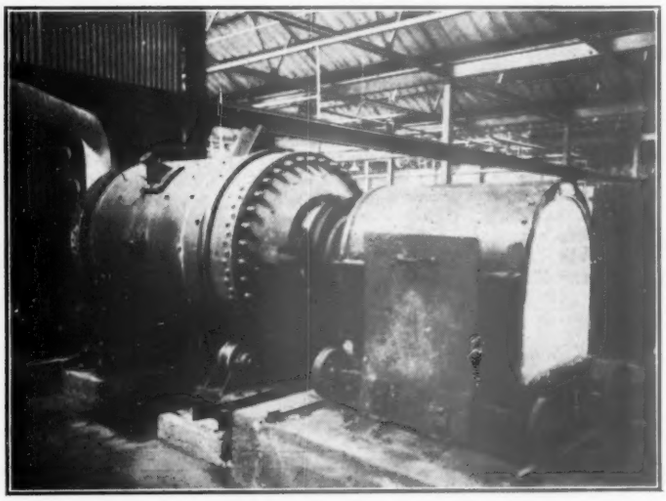


FIG. 4.—STEIN ROTARY OIL-FIRED FURNACE, 1-TON CAPACITY (RECUPERATOR NOT SHOWN).

Where it is desired to increase the carbon content over that of the original mixture, crushed petroleum coke is added, and with hypo-eutectic irons this is usually effective to the extent of 75 per cent. of the carbon contained in the coke.

TABLE III.—*Re-melting Borings in the Electric Furnace.*

	Total carbon, per cent.	Silicon, per cent.	Manganese, per cent.
Borings as charged	3.35	2.25	0.88
Melt as tapped ..	3.14	2.14	0.84

Lining Life

Linings of fused alumina, sillimanite, and rammed magnesite have been used for ordinary types of grey iron, and a lining of special magnesite bricks has been contemplated. The alumina or sillimanite appear to give satisfactory results on normal grades of iron—the life depending upon whether or not the lining is patched during its working life. It is understood that in America on furnaces which are patched each week-end linings have been in use two to three years. The sillimanite, and to a lesser extent the alumina, appear to be somewhat readily attacked by irons high in nickel and chromium. The best result so far attained is 150 heats for an alumina lining in the L.F.A. furnace. It is hoped by patching to obtain 200 heats before the lining is completely unserviceable. It is not general to use any flux in melting grey cast iron, although in the case of very dirty or rusty scrap some crushed glass may be used.

Economic Considerations

As with the oil-fired rotary furnace, it is not economical to utilise the furnace for holding metal for any length of time, largely on account of the current consumed, and partly because of the destructive action on the refractory material. Where it is desired to hold metal for any length of time, it is probably better practice to empty the contents of the electric furnace into a crucible furnace. It is obvious that a number of methods of using the furnaces are open to choice, amongst these being:—(1) Direct cold-melting; (2) direct cold-melting, mixing the electric-furnace metal with standard cupola iron; (3) duplexing cupola-melted metal with varying amounts of alloys and solid scrap, and (4) duplexing on the basis of constant additions of solid or molten metal and withdrawing the equivalent amount of molten metal.

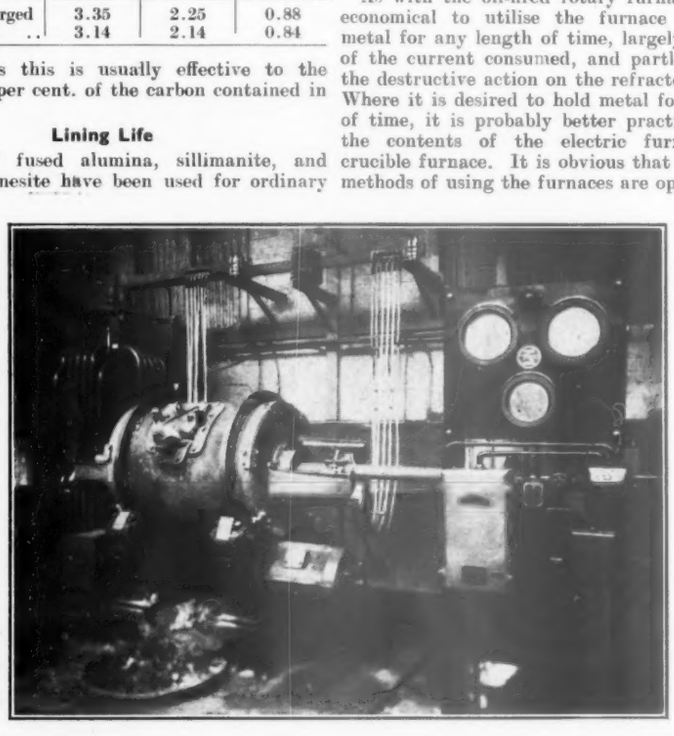


FIG. 5.—BIRLEC DETROIT ROCKING INDIRECT-ARC FURNACE (L.F.A. TYPE).

As this type of furnace has a high capital cost it is obviously desirable to minimise idle time. In arriving at melting costs, the water used for cooling the electrode holders and the cost of electrodes must be taken into account, in addition to the general items mentioned earlier. As with the oil-fired rotary furnace it is obvious that the electric furnace can only compete with cupola melting when low-value scrap is used. It is understood that in America charges of 100 per cent. borings are sometimes used, although personal experience has been that a high percentage of borings has not been an unqualified success for important work.

Conclusion

In the author's opinion the next decade is likely to witness the still further adoption of rotary furnaces for grey-iron melting and also a considerable extension of electric-furnace melting for high-grade castings. Electric-furnace melting would be greatly stimulated by a reduction in electricity charges. It will be realised that details of operation of various furnaces have not been exhaustively dealt with in this Paper, as the desire was rather to consider the principles underlying the choice of particular furnaces.

The author wishes to acknowledge his thanks to the Morgan Crucible Company, Messrs. Stein & Atkinson, Limited, and Birmingham Electric Furnaces, Limited, for illustrations supplied, to Messrs. Armstrong Whitworth, Limited, for information regarding lining life in Sesci furnaces, and to the directors of his own firm (the British Piston Ring Company, Limited) for permission to give this Paper.

L.M.S. Railway Contracts

NEW LOCOS AND WAGONS

In addition to the large works and rolling-stock programme for this year announced by the London Midland & Scottish Railway Company a short time ago, the company has ordered 3,040 new freight vehicles. The bulk of these will be obtained from the wagon-building trade. As in the case of the major programme, the new wagons are distinct from the works to be constructed under the proposed Government guaranteed loan. Of the 3,040 freight vehicles, orders for 2,690 have been placed with the following concerns:—Twelve-ton open merchandise wagons:—400, Hurst, Nelson & Company, Limited, Motherwell; 300, Metropolitan-Cammell Carriage & Wagon Company, Limited; 300, R. Y. Pickering & Company, Limited, Wishaw; 300, Birmingham Railway Carriage & Wagon Company, Limited; 200, Butterley Company, Limited; 200, G. R. Turner, Limited; 150, Craven's Railway Carriage & Wagon Company, Limited; 150, Gloucester Railway Carriage & Wagon Company, Limited. Twenty-ton tube wagons:—200, Charles Roberts & Company, Limited, Wakefield. Twenty-ton hopper wagons:—150, Metropolitan-Cammell Carriage & Wagon Company; 100, Birmingham Railway Carriage & Wagon Company. Twelve-ton medium merchandise wagons:—240, Charles Roberts & Company.

The L.M.S. Railway have also placed contracts amounting to £2,800,000 for 369 steam locomotives and 270 passenger carriages, embracing two of the items of work included in their programme of reconstruction and improvement under the Government Guaranteed Loan. The orders for the new locomotives and carriages have been placed with the following firms:—Locomotives: 227 4-6-0 mixed-traffic tender, Sir W. G. Armstrong Whitworth & Company (Engineers), Limited, Newcastle-upon-Tyne; 69 2-8-0 freight tender, Vulcan Foundry, Limited, Newton-le-Willows; 73 2-6-4 passenger tank, North British Locomotive Company, Limited, Glasgow. Passenger carriages:—Vestibule thirds (100), Metropolitan-Cammell Carriage & Wagon Company, Limited, Birmingham; (100) Birmingham Railway Carriage & Wagon Company, Limited; vestibule third brakes (50), R. Y. Pickering & Company, Limited; kitchen cars (20), Gloucester Railway Carriage & Wagon Company, Limited.

Vitreous Enamelling Section

DEALING WITH PAPERS PRESENTED TO THE INSTITUTE OF VITREOUS ENAMELLERS

The Preparation of Iron Castings for Vitreous Enamelling by Sand Blasting

By F. W. WILSON

In the preparation of this short Paper it was soon found that difficulties arose owing to the author's lack of knowledge on the enamelling side of the business. Some 35 years of experience in the building of sand-blast plants has proved that the requirements of enamellers vary in a very wide degree; consequently the types of plant in common use vary over a wide range both as regards design, operation, air pressure and abrasive. It is therefore proposed to divide this Paper up under the following headings:—(1) Types of plant used; (2) abrasives; (3) air pressures; (4) nozzles, and (5) operating troubles.

Plant Requirements

Under the first heading—plant—several Papers could be written on this alone, but, briefly, large work is done in room plants, the operator working in a helmet and working a hand-operated nozzle as required. These large plants are sometimes fitted with tables half in and half out of the room to facilitate loading and unloading, but as the maximum diameter of table that can be easily reached across by the operator is about 8 ft., limitations as to the size of work that can be dealt with on a table are soon reached. Specially-designed plants with conveyors running through the rooms are used to a limited extent.

On the smaller type of work rooms are still largely used, but, in addition, sand-blast tumbling barrels and automatic rotary tables, cabinets with the operator standing outside, and various automatic machines designed to deal with special work by directing numerous automatically moved nozzles on the work, are used in a small degree. The automatic machines, that is to say, machines where the jets are moved mechanically, have been developed in Germany and America on a much larger scale than in this country, probably due to the specialisation which takes place in these countries. It is safe to say that automatic moving jets do about half the work of hand-operated jets for equal volumes of compressed air used. This statement may be questioned, but is nevertheless true. Why small work is not cleaned more often in a tumbling barrel is one of the mysteries known only to the enameller, as this is a serviceable, simple and robust type of plant and cleans work in the most economical way known. In this country a number of automatic revolving tables are working on enamel work and some firms prefer them to all other types, as the operator is outside, but, on the other hand, some of the older firms who have had these plants working for many years have come to the conclusion that they are too costly to operate, and are replacing them with room plants where the operator wears a helmet and operates the jets by hand.

The automatic rotary table is ideal for cleaning flat surfaces, the edges of the castings being afterwards cleaned in a room plant, but air costs are high. Recently airless sand-blast plants have been placed on the British market. They have been developed in Germany and America. The velocity is applied to the abrasive by means of revolving paddles arranged in a similar way to the runner on a centrifugal water pump. Such apparatus was used in 1905 for throwing coal into retorts. The rim speed of the paddles is about 150 ft. per sec., this being limited by the bursting speed. Assuming the abrasive leaves the paddle at this speed (which is equal to a compressed air jet at about 1 lb. pressure or less) the cleaning effect is very mild. Large quantities of abrasive can, however, be thrown with the expenditure of small horse-power because the velocity is so low.

If the work turned out can be enamelled (and the experimental work seems to be favourable), this type of machine may be useful for work that can be brought under the wheel.

Low velocity sand blast was used 40 years ago, exhausters or fans being used to provide the blast. One is on the market in America using fan blast, and the use of fans is being investigated again, as they have advantages over the paddle and give a higher velocity, and avoid wear on paddles as the fan runs in clean air.

Each enameller generally prefers some particular type of sand-blast plant, but the following considerations should be considered for new plant:—Size of largest casting; proportion of large and small work; the quantity of small work robust enough to be barrelled; quantity to be cleaned per hr.; air-pressure considered most suitable for enamel to be used, and type of abrasive. Unfortunately the manufacturer of sand-blast machinery is not always given all this information, but is merely to supply some particular type of plant. Consequently much money has been wasted in the past on unsatisfactory plant. Every type of plant can be made in this country, cheaper and better than made abroad.

Dust Extraction

The best dust arrester for sand blast, where large quantities of fine dust have to be handled, is the bag type, arranged so that the exhauster runs in clean air. The various wet types all have the disadvantage that the sludge must be dealt with.

The efficiency of the various types are given* as follows by:—

Bag type, 99 to 99.5 per cent.
Cyclone, very low on fine light dust.
Wet type, very low on fine light dust.
Froth flotation, 99.7 per cent.
Modave Patent, 70 to 99.7 per cent., depending on number of factors.
Electrical precipitation very effective, but costly.
Soap bubbles, as used in South African mines, good but difficult to handle.

Any dust arrester should be capable of dealing with 7 to 10 times the volume of the sand-blast chamber to be exhausted per min. for good visibility.

Abrasives

The following are in general use:—

Sand, crushed flint, round and crushed cast-iron shot (and by the way there is no such thing as steel shot), and the various proprietary brands of abrasives made by the grinding wheel companies. This last material has not yet achieved great popularity. Sand and flint are the safest abrasives from the enameller's standpoint (wet process), but, owing to the dust which they create and the danger of the operator contracting silicosis from this dust, they have become out of favour with the Home Office. At the same time they are favoured by the enamellers, as the base of enamels are to some extent similar to these materials. Generally speaking, crushed iron shot is now the universal medium for cleaning castings for vitreous enamelling, but enamellers sometimes find it difficult to turn out consistently satisfactory work. Does the dust and smudge cause defects when shot is used, and is the same trouble experienced with clean shot? How does the oil in the compressed air affect the enamel? These questions must be left to the enamellers to settle, but modern plants are arranged to blast with clean shot, the smudge and dust being extracted before re-use of shot.

This crushed shot can be obtained in practically all sizes from the finest dust up to material that will pass through 10 or even 8 mesh, No. 16's being probably the most universally used abrasive.

Air Pressures

Probably no question in vitreous enamelling causes such a diversity of opinion as air pressure. It has been claimed that work cleaned at a velocity as low as 150 ft. per sec., and this represents practically less than 1 lb. air pressure, has enamelled satisfactorily. On the other hand, it is common to see work cleaned at 80 lbs. pressure, and 70 to 80 lbs. seems to be generally used, although pressures as low as 40 lbs. are used with satisfaction to the enameller. The above remarks apply to the wet process.

On the dry process from 30 to 60 lbs. air pressure is used. It was laid down in the early days of sand blast that the lowest pressure which would give the desired result was the most economical. This holds good to-day. In the Appendix are a few notes, written by one of the anonymous pioneers of sand-blast machinery, which are worth study, as they bear on this point.

Air Compressors

With modern air compressors:—

100 cub. ft. free air per min. requires 3½ h.p. for 5 lbs. pressure.
100 cub. ft. free air per min. requires 12 h.p. for 30 lbs. pressure.
100 cub. ft. free air per min. requires 18 h.p. for 80 lbs. pressure.

so that any reduction possible in air pressure should show substantial saving. It seems germane to ask whether high air pressure is used to prevent possible rejects after enamelling or to speed up output on a given size of plant.

All air compressors should be of the double-acting type with separate lubricating arrangements for air cylinder, so that adjustment can be made to prevent large quantities of oil passing over with compressed air. For air pressures up to 50 lbs. per sq. in., single-stage machines are satisfactory. Above this pressure, two-stage machines are desirable, as the efficiency is higher and temperature of compressed air lower.

Nozzles

The nozzles used with compressed-air plants are usually circular and made from chilled iron, as this is a cheap material, and at the higher pressures these nozzles last from one to two hours. Nozzles can be obtained made of various rare materials which will last a thousand hours or more, but they are costly. Any nozzle in use

* S. D. Moxley, FOUNDRY TRADE JOURNAL, October 24, 1935.

wears larger at the outlet, and this tapering of the bore causes a very serious loss in efficiency.

The reasons for this loss in efficiency are as follow:—At all pressures between, say, 10 and 80 lbs. to the sq. in., the compressed air enters the nozzle at a uniform speed of about 650 ft. per sec. The velocity at which it leaves the nozzle is unknown, but it must be very much greater than at inlet. This will depend on the air-pressure length and shape of the nozzle, the parallelism of the bore or otherwise, and many other factors. If one considers a grain of shot being carried along in the air current, when it enters the nozzle it will have a speed somewhat less than the air. When it leaves the nozzle its speed may be higher or lower than the velocity of the air. The grain of shot will move in a straight line unless it strikes the side of the nozzle owing to turbulence in the air flow. If the grain of shot strikes the side of the nozzle it wears away the metal. Let us now consider this grain of shot as it moves along the nozzle. The compressed air as it travels along the nozzle increases in velocity and, of course, a grain of shot likewise increases in velocity in much the same way as a bullet leaving a gun.

The question then arises as to what shape and how long the nozzle should be made so as to get the maximum velocity on the grain of shot. If the nozzle is short, the air is not in contact with the grain of shot long enough to impart the maximum velocity, and if made too long, frictional resistance of the air would reduce the velocity. This question of nozzle length requires further investigation, but, generally speaking, a nozzle 12 times the length of the bore gives good results. If the nozzle is allowed to wear bigger at the outlet than the inlet, there is a big fall in the velocity, as the air expands radially and the velocity is reduced. This is probably the greatest loss in the sand-blast process. It does not matter whether a chilled-iron nozzle is used or whether one of the long-life nozzles is used; the effect is the same.

The above argument, therefore, raises the question as to whether a circular nozzle is the best or whether elliptical, rectangular, triangular, or other shape of nozzle would not maintain efficiency for a longer period. Rectangular nozzles have been used with good results, but data is lacking as to the length of life and efficiency, as the parallelism of the inside of the nozzle is of such importance. Why use a round nozzle which cannot be kept parallel? Why not use a rectangular or triangular nozzle with one side adjustable, so that the interior of the nozzle could be kept parallel, or even made adjustable so that lower air pressures could be used for roughing out and higher pressures used for finishing the casting with a simple adjustment.

Operating Troubles

The most serious trouble met with in sand-blast plants is caused by water and oil getting mixed with the shot and preventing it flowing freely. Taking, say, a $\frac{3}{4}$-in. nozzle operating at about 80-lb. pressure, the amount of moisture carried in with the atmospheric air in 1 hr. is about $\frac{3}{4}$ gall. This has to be eliminated; otherwise it condenses in the pressure chamber. In addition to this, many compressors use not less than 1 gill of lubricating oil every 8 hrs. This also has to be eliminated. The oil does not present so much difficulty as the water, as it does not vaporise so readily. When air is compressed, the temperature rises until the entrained moisture is converted into steam, and this water passes over in a gaseous form to the air receiver. The air receiver gradually heats up, and the steam then passes over into the pipe line conveying the air to the pressure chamber. This heated aqueous vapour, on striking the cold parts of the pressure chamber, condenses, and so causes the abrasive to congeal. The simplest and most practical way of dealing with this problem is to heat the pressure chamber and the compressed-air pipe leading to the pressure chamber, so as to keep the water in a gaseous form. If the pressure chamber is kept warmer than the air receiver, no trouble should be experienced. A certain amount of oil passes through, and if this is allowed to reach the nozzle in the sand-blast chamber, it may cause defective work. The damp air does not seem to have any effect on the enamel. It is, therefore, of the greatest importance that the air compressors for supplying the compressed air are designed to compress the air with the lowest rise in temperature and to require the minimum amount of oil for lubricating the cylinders. A double-acting type of compressor is to be preferred for the above reasons, made either as single- or two-stage machine, and fitted with an after-cooler to condense as much of the moisture as possible before the air enters the air receiver.

Helmet Air Supply

This is taken from the compressed-air main and filtered through two or three media—usually water, coke and woodwool.

APPENDIX

Air Pressure for Sand Blast

One pressure of air is not the most economical for all uses. The grain of shot must deliver a blow of a force properly proportioned to the work that it is expected to do. A given horse-power of compressed air will impart a certain velocity to a given weight of shot per min. and no more. If this velocity is sufficient, then doubling the velocity of the shot will reduce the factor of economy of the machine to 25 per cent. of its former efficiency for these reasons. At double the velocity, each grain of the flying shot will contain four times the energy as the same grain at the lower velocity.

There is more slip, so to speak, between the shot and the impelling air at higher than at lower velocities. At lower velocities the comparatively lower pressure air imparts more nearly its own velocity to the shot than does the higher pressure air moving at a greater velocity.

These conclusions are true of any type of sand-blast machine, but with the flexible-hose type of machine they are still more intensified for the following reasons:—In any event, the long flexible hose is a source of loss of power for the obvious reason that every time a grain of shot strikes the soft elastic lining of the hose it loses a very considerable portion of its velocity and drops back into the current at a reduced velocity, which must be again imparted to it if it is not to drop, and by a repetition of the process finally come to rest and clog up the tube. For this reason the larger the diameter of the hose and the less the velocity of the mixed stream of shot and air passing through it, the less is this loss, because the larger the hose the greater the ratio of its cross-section to the area of its walls, and therefore the fewer are the impacts of the shot grains passing through it within its walls, and also, owing to the low velocity, the less is the loss at each such impact.

The force necessary to give velocity to the air is in itself without effect in sand-blasting. Only the force which is imparted to the shot is useful. One other point in regard to the proportioning of the velocity to the work to be done. One might readily imagine from the above reasoning that a still lower pressure would be still more economical. In general this is so, for when sand is used on work like the depolishing of glass, where the removal of any of the substance is not desired, but only the roughening of the surface, where the effect will be produced at a very low velocity, it is most economical to use air pressures as low as about 1 lb. to the sq. in., the reason being that at that pressure each grain of shot completes the work by striking the surface, and the same surface does not require a blow from another grain of shot. The same applies to cleaning and casting of forgings. At 10 to 20 lbs. per sq. in., depending upon the nature of the shot or scale to be removed, each grain of shot cuts down to the clean metal, and the same spot does not require another blow to complete the work.

If the blow were weaker, too weak to finish the work at each impact, so that a second and third blow were required to complete it, then that process would be less economical than when it was finished at one blow. It can, however, readily be seen that even this would not be so wasteful as making each blow several times as hard as is necessary to clean down to the metal each time it is struck, for if this were done a great proportion of the force of the blows would be wasted on the clean metal beneath the shot and scale which is required to be removed, instead of being practically all expended in removing the shot or scale.

DISCUSSION

The occasion for the presentation of this Paper was a meeting of the Institute, held in Manchester, which was presided over by Mr. H. Whitaker, of Keighley, who, in introducing the lecturer to the meeting, mentioned that one point which had always puzzled him in connection with sand-blasting was, what was the exact air pressure necessary for vitreous enamelling? He was also anxious to learn what was the best diameter, as well as the best type, of nozzle to use. Information was also desirable concerning the so-called permanent nozzles. The removal of moisture and oil from the compressed air used was also a problem which had to be solved, while doubtlessly most, if not all, of those present would like to be informed with regard to the practicability of a sand-blast plant exhibited at the recent exhibition which was operated without the use of compressed air.

The CHAIRMAN said that it was a rather remarkable statement that the shot impelled from the airless sand-blasters paddle at a velocity of 150 ft. per sec. was no more effective than an air pressure of 1 lb. per sq. in. It was quite obvious from the statements in the Paper that very little was known about the fundamentals of sand-blasting, and that it was pre-eminently a subject to be taken up for consideration by the National Physical Laboratory.

MR. J. T. GRAY (London) congratulated Mr. Wilson on his excellent Paper, as shot-blast equipment was a very important factor to the vitreous enameller. With regard to the lecturer's statement that mechanical nozzles only did half the work of the hand-nozzle, this depended on a considerable number of factors. First, the disposition of the nozzle and the method of using it, and what was even more important, the class of work being dealt with. As to the mechanical nozzles only being suitable for flat work, he had had experience in a number of works, including those in the electric, range and gas-stove trades, where, of course, the majority of the work was on light castings, and in these works mechanical nozzles, that is, rotary tables, were used, and for the last three or four years an arrangement of nozzles had been adopted which enabled the edges as well as the flat parts of this type of casting to be thoroughly cleaned. In fact, all castings of this type are taken straight from the rotary table to the sprayers. If one has to deal with castings having flanges from 4 in. to 6 in. deep, that is another matter.

Respecting the airless machines, he understood that Mr. Wilson was referring to the "Wizard" and "Wheelabrator." With regard to the "Wheelabrator," it was claimed that the velocity of the shot leaving the periphery of the paddle was equivalent to that obtained from air blast of 80 lbs. per sq. in. One point of general interest was, what percentage of the cleaning was effected by the velocity of the shot as compared with that of the rumbling action of the shot between the castings? While

rumbling may assist with the cleaning, rumbling alone had not been found suitable for the vitreous enameller.

MR. GRAY asked how the efficiency of various filters and settlers was arrived at. On the subject of the wear of nozzles the lecture mentioned that the length of the nozzle should be from ten to twelve times its diameter, and he could not see how the track of the wear could be determined.

MR. GRAY pointed out that there was considerable data available on the flow of gasses through orifices and pipes, and this data can be applied to ordinary sand-blast nozzles to a considerable extent. With regard to the length, which had been given as ten to twelve times the bore diameter, it is a known fact that minimum friction results when the length is four times the bore diameter. In shot-blasting a considerable variation in pressures is used throughout the enamelling industry, and the question of the most efficient pressure is a very debatable point, as this depends entirely on the type of apparatus being used and the castings being treated; a further important factor in this connection is the foundry practice behind the operation.

In good-class foundries where a large percentage of the work is required for vitreous enamelling, special attention is paid to the prevention of burnt-in sand and the adjustment of gates and risers. In some foundries where it is found necessary to hold large stocks of raw castings, the higher pressures are usually applied in the shot-blast.

The point on the ratio of wear of nozzles was of interest to the enameller. Mr. Wilson had stated that with chilled-iron nozzles about 10 min. of full efficiency was obtained, after which there was a continuous falling away owing to the wear of the nozzle and that in the long-life nozzle this falling away was proportionate. Mr. Gray hardly thought this could be correct because wear on the harder nozzles was not so fast. In the case of the chilled-iron nozzle the area of the nozzle might be increased two or three times before the nozzle was scrapped, whereas the long-life nozzle could only be increased in area about 30 per cent. before being scrapped.

On the point of cost, the long-life nozzle, the cost of which is approximately 56s., will only show a small saving as compared with the price of the necessary number of chilled-iron nozzles for an equivalent life, but the major saving lay in the time factor—in changing the nozzles.

MR. A. CALDERBANK (St. George's Engineering Company, Limited) asked whether the long-life hard nozzle mentioned was a proprietary type of nozzle.

MR. GRAY replied that it was not a proprietary type, and his company is distributing these nozzles throughout the trade. It is a conical nozzle with an inlet bore of $\frac{3}{4}$ in. and outlet bore when new is obtainable in sizes from $\frac{1}{4}$ in. to $\frac{3}{8}$ in. The length of the nozzles is about 2 in., and adapters could be made to fit these nozzles to any type of machine. In fact, most users make up their own adapters. These nozzles are used in rooms, cabinets, barrels and rotary tables.

MR. WILSON thought that a great many of the points he had raised in his Paper should be dealt with by the N.P.L. aided by some practical enameller and sandblasting expert. An individual worker would require a very extensive laboratory and a quantity of expensive tackle to do the necessary research work. To determine the velocity at which air left the nozzle, together with the appropriate shape of the nozzle, would probably keep one research worker busy for a year. He suggested that a committee be appointed by the Institute with a view to considering the possibility of collecting data germane to the subject. Sandblasting was an expensive process for even with quite a small plant there was considerable power behind the nozzle.

Some people seemed to get very much higher outputs than others, but, generally speaking, there appeared to be a decided loss in output with mechanical nozzles as contrasted with hand nozzles, probably due to the fact that a lot of the work put on to the rotary tables was not suitable for that class of machine.

He had tried the rumbling of castings with shot, and, like Mr. Gray, had not found it too satisfactory. In the old days it was considered good practice to use velocity low enough to move the scale at one pit. Probably a far better arrangement would be to have a fan blowing air, and drop the shot into the air current. The fan would be running in clean air. This was one of the oldest constructions of sand-blasting he could remember, and there could be no wearing parts to become out of balance.

With regard to ascertaining efficiencies of the bag filters, the usual method was to have a fan on each side of the dust arrester pulling out equal volumes of air. The formula was that W was the weight of the material in the bag on the dirty side, and w was the weight on the clean side efficiency $= \frac{W - w}{W}$

If there were 10 lbs. of dust in the W bag and one lb. of dust in the other, the efficiency was 90 per cent. A Paper which had been published in the October 24 edition of THE FOUNDRY TRADE JOURNAL was well worth reading by anyone interested in dust problems. It contained some very interesting information, particularly as to the kind of dust which was injurious. Apparently, it was the finest dust which gave the most trouble.

Nozzle Velocity

He did not think that four times would be sufficiently long to give the maximum velocity from a nozzle; the length should be such that wear ceased at its end.

It was really surprising how much air pressure was required to remove the scale on some castings as compared with others. He did not know whether this was due to the fact that a good deal of what might be termed "synthetic sand" was being used, or whether it was owing to the fact that skilled moulders were not employed on the job, or even whether it was due to the ramming up, but there was no doubt about it that some castings were very difficult to clean.

Length of Nozzles

The problem of the length of nozzle was definitely one for the N.P.L. to solve; short nozzles were required for low pressures and long nozzles for high pressures. All long-life nozzles were made short for reasons of cost. The tungsten carbide nozzle, apparently, was only made in Sweden and at Krupp's works at Essen. They were made in electric furnaces. The mould was machined and a temperature of approximately 3,000 deg. C. was necessary, one good product being obtained in three. Any method which would enable a nozzle to have longer life and keep in good shape was well worth consideration. Long-life nozzles were usually very hard, and, in the hands of a sandblaster they might be easily broken. Another factor for consideration was that they were not sufficiently long to get into awkward corners. The men could not get down into crevices with them, and therefore they did not like them for that reason.

History of Chilled Iron Shot

MR. W. H. LYNN (Middlesbrough) observed that chilled-iron shot was introduced by John Marks, of America, into this country, although, as a matter of fact, it was first manufactured in Burnley. It was manufactured in Middlesbrough 28 years ago. The best shot was made from machinery scrap, and the cost was very high. The best angular grit could only be made from the outsizes of the shot. About 30 tons were made at a time, and, at the most, only about 3 tons of it could be guaranteed to be of any particular grade. In order to crush the shot, very expensive manganese-steel rollers were necessary, the life of which was very short. "Corner grit" was introduced into this country years ago from America, and cost £3 a ton. It could not be crushed effectively, and the result was that it used to wear round and lose its usefulness.

MR. ROBERTS (Harrison Bros., Middlesbrough) remarked that he had never yet heard anything like a satisfactory explanation of the moisture problem. How was it possible to keep the temperature equal, particularly in cases where the compressor house was very far removed from the sand-blast?

Grit Manufacture

MR. WILSON thought it was not realised by most people who used shot that, when the shot was being made, there was a considerable loss in fine dust. There was a quantity of fine stuff that was not really useful, as well as much oversize. The secret of a successful shot business was to have a market for all grades. The larger grades were used for boring purposes in South Africa. Unless the manufacturer had the whole world as a market, the shot question was one which presented great commercial difficulty. The molten metal was atomised, as it left the mouth of the cupola, by means of a steam jet, sprayed out, and dropped into a water tank. That was a crude way of getting sizes, and the result was that a great deal of shot was produced for which there was not a very good market. Therefore, those people who wanted certain sizes had to pay heavily for them in order to make up for the loss on scrap and commercially useless sizes.

The Moisture Problem

The moisture problem had been a bugbear ever since he had been in the business, and it became increasingly difficult as the pressure rose. The reason was, of course, that for every cubic foot of compressed air there was more moisture. A certain amount of moisture left the compressor in a heated form. It was not water then, otherwise it would stop in a receiver. It was in the form of steam. When it reached the receiver, theoretically, if the receiver was cold enough, it should condense the steam and the condensate should remain in the bottom of the receiver, but, as a matter of fact, this was not the case. One remedy was to have an after-cooler, and cool the air immediately it left the compressor as low as possible, so that the steam would condense. Some would remain in the after-cooler and some in the receiver. Most people, however, would not go to the expense of this arrangement.

Freezing Out the Moisture

Some people he knew, who had had trouble with paint spraying, put in a refrigerator and froze the air on the delivery pipe. This worked quite well, but they were now using a receiver packed with wood wool and some sort of paper, which was quite satisfactory. It took out the oil and the water, but it was only suitable for small volumes, such as were used with paint or an enamel spray. Whenever large quantities of air were used, then large quantities of water would have to be dealt with. He thought he could safely assert that the best way was to put in an after-cooler; if that did not settle the matter, then heat the pressure chamber and compressed-air main, or cool the air first to remove as much water as possible, then reheat air to neutralise remaining moisture left after previous cooling.

MR. A. CONNELLY (Rustless Iron Company, Limited) could not agree that heating the pressure chamber would do away with the trouble. He spoke from experience. He could recommend the installation of a good air filter, without heating the chamber at all. His objection to heating the mixing chamber was that the water and the oil were condensed on to the job, which was harmful. The wear in the majority of nozzles he

had seen had been mainly in the centre, and apparently there was no loss of velocity, in fact it was rather increased. He had seen work come off the "Wheelabrator" which was thoroughly clean, and as good as that from a normal sand blast.

MR. WILSON said that immediately the air left the nozzle it absorbed moisture from the surrounding atmosphere. The trouble was most pronounced on Monday morning, when all parts of the plant were very cold. As soon as air came in contact with anything colder than itself moisture was condensed. Possibly a certain amount of water was condensed on the sides of the hoppers and was washed down by the shot into the pressure chamber.

More About Nozzles

With respect to nozzles wearing halfway, the nozzle problem was one of the most serious difficulties in connection with sand blasting, and yet it was one about which practically nothing had been done. The wear on some of the nozzles was exactly as Mr. Connelly had described. It started half an inch up and swelled very rapidly for another inch and a-half, and then went parallel. He had reached the conclusion that this effect was due either to porous metal or turbulence of shot caused by the lead-in being of an incorrect angle. There was definitely a "blown" spot on the collar, due to the man not having fed it in the correct place. Of course, the nozzles only cost a copper or two, so that too much could not be expected. A nozzle should be of uniform hardness from end to end, homogeneous, and have no spongy spots in it. It was reasonable to suppose that if there was any turbulence in the air the trouble would take place where there was the greatest air space. If the air were led into the nozzle through a badly shaped inlet the shot would bounce about in the nozzle from side to side. It was necessary to avoid this. In order to get a proper lead-in machining was necessary, and, in the old days, he used to grind the nozzles to perfect the lead-in. Until the question of velocity at the outlet was settled very little could be done in regard to the nozzle as regards either length or anything else. Where the velocity was greatest, the wear would be greatest. With a perfectly parallel nozzle, machined accurately, something could be learned, but with a cast nozzle it was hopeless, as there were too many variables.

Aged Castings Preferred

MR. F. MURRAY said the bell formation inside the nozzle might be caused through the shot building up. He thought that a cost of 1½d. was too high. With respect to the moisture problem, the Monday morning effect did not trouble him. He endeavoured to bring up the air receiver to a fairly high temperature after having started the compressor. Having done that, the air receiver was exhausted, the air was turned on to the pipe-line going to the apparatus, and there was a means of taking the moisture off at that point. Personally, he preferred to deal with castings which had been in stock for some time and had become aged.

MR. WILSON said that it had always been his practice to age castings, particularly cylinders which had to stand hydraulic pressure.

MR. W. V. CLEVERLY (Carborundum Company, Limited), referring to the removal of water from compressed air, said there was an American apparatus in which the air was fed tangentially into a chamber, impinged on a metal baffle, and the bulk of the water ran down grooves into the receiver. After that the air passed through the walls of a permeable ceramic tube and trapped the remaining moisture. Such a plant is understood to be applicable to sand-blasting pressures. With regard to nozzles, everyone seemed to consider that hard materials give the best results; but, by analogy with what had been found in ball-mill linings, was it not possible that a softer material, such as rubber, might prove more efficient?

MR. WILSON said that rubber behaved in a somewhat peculiar way. It did not last for more than half an hour and it seemed to burn through. It was well known in sand-blasting that with such forms of rubber, particularly with sand as an abrasive, very high voltages were generated, and sometimes a spark 3 in. to 9 in. in length was emitted, very much to the discomfort of the operator if he received a shock under the arm. A copper wire was sometimes necessary for earthing purposes.

MR. R. W. WHITTLE (W. H. Whittle & Company, Limited, Eccles) also approved of the ageing of castings. Respecting the removal of moisture from air, he mentioned that in large electric-power stations the very large generators were all ventilated by cleansed and dried air.

MR. J. T. GRAY said that in view of what had been stated on the ageing of castings, he considered that it should again be mentioned that a considerable proportion of the trouble experienced with castings during enamelling was not so much from a metallurgical point of view, but owing to the fact that the castings are porous and difficulty arose from the occluded gases. The longer castings are left over between moulding and enamelling the greater the trouble through boiling. In his opinion, castings obtained direct from the foundry were the easiest to enamel.

MR. MURRAY, personally, preferred to take castings out of stock for the purpose of enamelling, though he agreed with Mr. Gray with respect to the occlusion of gases if a casting had been allowed to lie about for some time.

MR. A. K. WILLIAMS (W. H. Whittle & Company, Limited) said that there was a possibility that weathering loosened impurities in the surface of the casting, which enabled the subsequent sand-blasting to remove them easily.

The proceedings concluded by the passing of a vote of thanks to Mr. Wilson for his extremely interesting communication.

Heat-Resisting Alloys

ECONOMIES TO BE REALISED

At a meeting of The Institute of Vitreous Enamellers, held on December 12 at British Industries House, London, over which Mr. B. B. Kent presided, MR. J. FERDINAND KAYSER, Assoc. Met., chief metallurgist to Gillette Industries, Limited, gave an address on "Heat-Resisting Alloys," during the course of which he said:—

The products of the ceramic industry are many and varied, and each branch of the industry is characterised by operations peculiar to it. In every branch there is, however, one or more operations which depend upon high temperatures and in which parts made from heat-resisting metals may be economically utilised. Not only may they be used to replace wrought- or cast-iron parts whose life must necessarily be short, but they may be put to uses for which units made from ordinary metals are totally unfitted.

The conditions under which heat-resisting alloys are required to work vary to an enormous extent, not only in regard to temperature but also in regard to the atmospheric conditions and the stress to which they are subjected. Consequently, a number of different heat-resisting alloys have been developed, each with its own peculiar characteristics. In order to be able to judge whether or not a heat-resisting metal may be economically applied for any particular purpose, and, if so, to choose the best possible metal for that purpose, it is necessary thoroughly to appreciate the nature of the conditions under which the metal will have to work, the properties of metals at high temperatures in general, and the properties of the available heat-resisting metals in particular.

Effect of atmospheric temperature changes on physical properties of many substances is well known. Ice, water, steam is a case in which solid, liquid and vapour exist side by side. For many years it was not recognised that metals fell into the same class as sealing wax. Even to-day many manufacturers think, or at any rate say, their alloys have the same tensile strength hot as cast iron or mild steel cold. However, in 1922, Dickinson first showed the fallacy of the above misnomer.

In 1928 Hatfield showed that at ordinary temperatures mild steel stressed at 6 tons per sq. in. above its yield did not attain stability until 22 hrs. had elapsed.

Phenomena encountered in testing sample of very hard steel are simple. Test-pieces will ultimately rupture without appreciable change of dimensions and elastic limit and maximum stress coincide. In case of a ductile metal the phenomena are more complex. When the yield point has been passed, any increase in stress causes a reduction in area of the test-piece and the stress per unit area necessarily increases at a greater rate than the increase in actual load. If there were no such thing as strain hardening, it is obvious the test-piece would continue to elongate at an increasing rate until rupture occurred.

As the temperature increases, the properties of metals gradually change, until a point is reached where, if stressed sufficiently, the sample elongates with increasing rapidity until fracture ultimately occurs. According to Chevenard, this change of direction is not explained quantitatively solely by the increase of the load per unit area due to the reduction in area of the test-piece, and he concludes that under certain conditions metal which has flowed becomes more likely to flow.

After stressing the importance of knowing the real strength of metals, Mr. Kayser dealt with the question as to whether metal had true strength at elevated temperatures, and followed this by outlining his personal experiments on scaling.

In the final part of his lecture he dealt with such subjects as heat conductivity, various types of heat-resisting alloys, such as Ni-Cr-Fe, Fe-Al, Fe-Si, Cr-Al-Fe and Ni-Al, scaling temperature, and creep results.

His concluding remarks were devoted to surface protection by spraying, calorising and plating.

DISCUSSION

The CHAIRMAN (Mr. B. B. Kent) asked whether "heat-resisting alloys" meant that there were no heat-proof alloys. Vitreous enamellers made burning bars of various compounds, but after about two years these bars scaled and had to be thrown away. Was there an alloy which would stand up more or less for ever at 800 deg. C.? The lecturer had also mentioned that if a metal was cadmium plated, presumably iron, and it was plunged into aluminium, a reasonably heat-proof material was obtained. Most vitreous enamellers had jobs occasionally that needed special bars, but which would not warrant the expense of material at 4s. or 5s. a lb. Would he recommend the

method just mentioned as a good way of making provisional bars?

Heat-Proof Alloys

The LECTURER replied that there were no heat-proof alloys. The difficulty was that one could not get away from expansion. If the alloy was examined, it would be found that continued expansion and contraction caused opening-up, so that ultimately disintegration supervened. He had seen a test-piece in Germany which had now been maintained at a high temperature for something like ten years, and was still perfectly good; but another piece, which was heated and cooled regularly, failed in something like six months. The factor was the opening and closing, and, as soon as disintegration started, pieces fell out and the component disrupted. He did not think that vitreous enamellers would find it worth while to cadmium-plate and dip in aluminium, because the plant for that was somewhat complicated. A number of firms, however, were spraying with aluminium, and it would be well worth while to send along components to one of them. However, care must be taken to send to someone who would not only be capable of carrying out aluminium spraying, but also possessed sand blast. The process is to aluminium-spray, lacquer, and then let the article soak at about 700 deg. C. for a short time. Then there would not be an increase in strength, but there would be a resistance to scaling at, say, 900 deg. C., which was, he thought, a very useful temperature.

Influence of Cobalt

MR. J. H. COUPE asked what result the addition of cobalt to nickel chromium would have on heat-resisting properties.

The LECTURER replied that adding cobalt to a heat-resisting alloy slightly reduced its properties. He had made a diagram in which nickel was replaced by cobalt. The more cobalt introduced, the worse the alloy.

The Follsain Process

MR. J. BUTLER asked if Mr. Kayser could give any information regarding a new process which he understood had been very successfully used for protecting annealing boxes for annealing tin plates. It was a process whereby the surface of the metal was impregnated with aluminium. It was not calorising. It was known as the Follsain process.

The LECTURER said that he did not know the process referred to. Was the questioner thinking of a process where one painted the object with water glass to get a refractory surface?

MR. BUTLER pointed out that it was an alumino-thermic process which included chromium in its make-up.

The LECTURER stated that in the Black Country annealing boxes often weighed 2 or 3 tons, and the suggestion that this should be made from a nickel-chromium alloy was indeed extravagant. The process Mr. Butler referred to might be useful for such a thing, because making a component as big as that for an annealing box was not worth while; but furnace parts were now made in Russia weighing up to ½ ton each, and one furnace part had been made in Germany which weighed 5 tons. This was a furnace bottom about 10 ft. by 5 ft. 6 in. thick.

Lacquering Effects

The CHAIRMAN said Mr. Kayser had mentioned that when the bars aluminised, they should be lacquered, but surely the lacquer burned up immediately the bar was put into the muffle.

The LECTURER replied that actually, among the best things one could use, were some of the bakelite lacquers. These seemed to crust over and just give time for the aluminium to start alloying with the underlying metal before the heat got through. He did not know that bakelite was the only thing, but he had found it very effective. Of course, it became carbon practically straight away.

Calorised Alloys

MR. ABBOTT said he would like to endorse Mr. Kayser's remarks as to the value of calorisation. He had had an experience of a small tubular furnace with a silica muffle. The furnace was gas-fired, and to ensure uniformity of temperature along the tube it was necessary to enclose it in a metal sheath. First of all mild steel was tried, but owing to oxidation this was rendered useless after the first heating-up. Then a similar steel tube was calorised. This was continually heated up to 1,000 deg. C. and proved good for six months. He was interested in Mr. Kayser's opening remarks about the birth of the heat-resisting alloy. He thought the average period of incubation of scientific discovery was twenty years. This alloy embryo had lived for over a hundred years. Could Mr. Kayser say whether the first alloy composition of 1792 bore any relation to the compositions used to-day?

The LECTURER replied that the 1792 alloy definitely did. It was to all intents and purposes nickel cast iron. The specification suggested adding from ten to twenty per cent. of nickel in cast iron in order to make a non-oxidisable alloy. Then the patent went on to describe a salt bath for case hardening. The process certainly would make a good alloy, and the only reason it had not anticipated several patents was the fact that an anticipation more than fifty years old was no anticipation. He did not know the name of the original patentee but he was a Birmingham man.

MR. CHIFFEY said he had tried aluminisation in a small way as mentioned in a booklet issued by a well-known supplier of industrial gases. It resisted scaling to a great extent, and was recommended in the booklet for furnace bars and for vitreous enamelling.

Iron-Aluminium Alloys

MR. FRY said he noticed that the lecturer dismissed iron-aluminium alloys rather summarily but it did not appear why. As he saw it, chromium alloys were adequately heat-resisting for the purpose of vitreous enamellers, and they had the desirable degree of mechanical strength at temperature for working; but operators were worried by the fluxing action of the enamel. He had not proved it, but so far as his experience went he believed he was right in saying that aluminium-iron heat-resisting alloys were not so badly affected in that respect. He would like to know whether anyone present could confirm his remarks?

The LECTURER said he could confirm that. From a surface point of view under all conditions he would say that an iron-aluminium alloy was better than a nickel-chromium, but there were great manufacturing difficulties and one did not obtain strength at high temperatures. It was cheap; aluminium might be taken at one shilling a pound and iron at a penny a pound, and from seven to ten per cent. of aluminium would be ample. But the manufacturing difficulties were outstanding. The people who were making great efforts at it now were the Germans, who had aluminium and iron but no nickel. They had a certain amount of chromium. He thought that ultimately much might be heard of great developments in Germany of this alloy. In some ways it was soft. It forged nicely, it could be bent and drawn into wire; yet it was brittle. It had similar properties in the heat to a thirty per cent. chromium in the cold. A thirty per cent. chromium could be drawn into wire, it could be drilled, and machined, but if it were dropped or hit with a hammer, it would break. People said in an airy way that it was a matter of crystal growth, but other alloys with excessive crystal size did not behave like that. There was some property of the metal which was not understood.

Fundamental Strength

MR. COUPE said there was one point he was not clear about. The lecturer had referred to the tensile strength of the alloy, and its heat-resisting property. Did any alloy with greater tensile strength have greater heat-resisting property?

The LECTURER replied that if he used the words "Tensile strength" he did not intend to, except when he was talking about the useless sort of quick test. He had said "strength." Undoubtedly if it was a question of structure the higher the strength—which most people called the "creep" value—the longer the time the structure would last without scaling. Many metallurgists said that with high temperatures there was no such thing as true strength, and that if the slightest load were imposed sufficiently long, the metal would extend and ultimately rupture. But as the result of his work with Rohn's apparatus he had reached the conclusion that these things definitely had a strength though a very low one. If one wanted to get anti-sagging in a bar, undoubtedly the higher the strength the better. Scaling must be examined separately, but it should not be forgotten that the stronger a metal was in the cold, the stronger it would be in the heat. It should be remembered too that the strongest possible metal in the cold was very brittle indeed. The late Dr. Rosenheim had suggested a metal very high in carbon, and if reference was made to his papers in conjunction with Dr. Jenkins extremely high figures would be found there for strength, or "creep," if that name was preferred. He (the Lecturer), could confirm those figures, but as the alloy cooled it became so brittle that it would scarcely hold together. It would always fracture whenever it was allowed to cool down.

Pure and Impure Alloys

MR. K. HILL said he had noticed that Mr. Kayser was very much interested in the remarks about treating metal with aluminium, and subsequent treatment as to its resistance to scaling. What was the effect of aluminium as an anti-scaling resistant? In the earlier part of his lecture Mr. Kayser had said that if the iron content was increased the scaling possibilities were reduced in an alloy. Was it a particular kind of iron that was introduced? In other words must it be to a certain definite analysis, or could it be commercial iron?

The LECTURER said that the process had very little effect on heat-resisting properties. On mild steel it increased the scaling resistance a little but if one exceeded 650 deg. C. it went at once. What he had said about iron was that iron did not necessarily act detrimentally in an alloy, but if you put in too much it did. It was quite right to ask what was meant by "iron." That evening he had not been very precise; he had spoken of nickel, iron and chromium; but if one used pure nickel, chromium and iron one would get a metal that would be useless. If a somewhat impure iron and impure chromium was used, one was thereby introducing some most important ingredients. In the first place carbon: in order to get strength in an aluminium or silicon free alloy, carbon was necessary. Incidentally, it was very desirable, from a casting point of view. Mond nickel was generally used because it was not possible to buy more cheaply, but it was unnecessarily good. One could use as a base mild steel containing sulphur, phosphorus, manganese, silicon and anything likely to be found up to one per cent. For chromium the best thing was a ferro-chromium—60 per cent. chromium and 2 per cent. carbon, always remembering that the carbon in the finished article should not be too high. The detailed composition of a very desirable alloy was:—Carbon, 0.6; nickel, 60; manganese, 1; silicon, 1; tungsten, 2; and chromium, 20 per cent. This was quite a long way removed from a pure iron. In making a resistance for electrical stoves one should use the purest iron

obtainable. Continental specialists such as Dr. Rohn melted everything in a vacuum furnace and he believed that he (the Lecturer) was one of the very few outside metallurgists who had ever seen this furnace. It was an exceptional device—ingots were cast in it weighing half a ton each. These were melted and cast in a vacuum. During the melting down period there was a difficulty in maintaining a vacuum because of the evolution of gas, but after that it was kept down to one millimetre of mercury or thereabouts. The ingots were really nickel iron chromium, but Dr. Rohn would be the last person to say that one should use them if one wanted real strength. For the sort of metals he (the Lecturer) was referring to they should use something impure, but they should not use cast iron. He did not think it was an improvement to make a thing worse. Many cast iron specialists discovered that if they added nickel and chromium to cast iron they got a heat-resisting alloy. They were really taking a heat-resisting alloy such as he had spoken of and adding to it a lot of carbon, making it worse. There was nothing new about that. This was one way in which he thought the National Physical Laboratory sometimes went sadly astray.

Strength of Perrits

MR. A. L. FAWKES said he had been interested in the remarks on the nickel-chromium alloys. He would like to come back to the enamelling industry. The question was how light could they make a nickel-chromium bar to do its job. There was a definite line somewhere between "creep" strength and rate of oxidation. That was to say, that if one took a particular bar in the furnace which was overloaded, the rate of oxidation would be a certain figure. This rate would be lower when not overloaded, and the point to reach was the relation between "creep" strength and rate of oxidation: he meant in a clean atmosphere in an enamelling muffle, but complicated by compounds and mixtures placed on the nickel-chromium perrits. A second point was that in the 7 to 20 per cent. nickel-chromium, Mr. Kayser gave a figure of 500 lbs. "creep" value at 900 deg. C.

At 1,000 deg. C. there was a drop to 100 lbs., and he would like to suggest that the figures would be correct in practice between 800 and 900 deg. C., *i.e.*, 100 deg. C. lower in each case.

In the comparative figures for heat conductivity, Mr. Kayser had shown the conductivity of the 60 per cent. chromium and 20 per cent. nickel alloy. That conductivity figure on an alloy of 60 per cent. nickel and 20 per cent. chromium should be very interesting, because he thought that this was the alloy that had been developed for enamelling work, as this was the principal alloy on which weight could be minimised for the furnace. Another important point arose; this was the proportionate weight of sheet work going into the muffle to the weight of perrits carrying it. That was to say, if one was using a heavy perrit one might have as much as ten times weight of perrit as weight of work.

The point he wanted to make clear was that if one were loading with a very high-class alloy perrit one could bring this factor down to four of perrits to one of work proportionate weight; whereas, in using a heavy bar, there was considerably more weight of perrit in the muffle with consequent heating costs, etc., entailed. 600 deg. C. had been given as a fair figure for the nickel-sulphide melting point with the nickel extracted from nickel-chromium; he took it at about 750 deg. C., but supposed that 600 deg. C. could be verified as a more accurate figure. With regard to 30 per cent. chromium-iron, members may be interested to know that skid bars were very successfully made of that alloy on account of a development of "greasy" surface when this mixture is heated at very high temperature.

On certain perrits carrying heavy loads in the enamelling muffle, it was calculated that the strain imposed was round about 3,000 lbs. per sq. in., and the effect of the overloading was so slow in making actual deformation of the bar that the design was quite practicable.

In some cases overloading could be generous, in other cases one must not work much over the figure for "creep" strength per sq. in. at 900 deg. C. given by Mr. Kayser.

Calculating the Cost

The LECTURER, referring to strength, said that the method mentioned 100 lbs. at 1,000 deg. C. and 500 at 900 deg. C. At 800 deg. C. it was 5,000 lbs., and then the rate of increase was just about constant. At 700 deg. C. it was about 14,000 lbs. The curve became steep towards the end, and as the temperature fell away the increase in strength was very rapid.

The question of thickness was a most complex one. It was very difficult to arrive at the truth because competition played such a very big part, and manufacturers were not thinking so much about the best pettit for the job as thinking how to get an order. Within rather wide limits they would sacrifice a great deal to get an order, and the tendency was to make the pettits thinner and thinner. But that was altogether wrong. The user should work out the problem. In the first place he should think of his furnace. He knew what his heat costs were. He was going to charge his carrier with all his pettits on, load and work, and heat up to 900 deg. C.; and the first thing was to make a few calculations as to what it was going to make in fuel costs, and then estimate the cost of the pettits. In these days it was possible to buy a pettit weighing up to, say, 10 lbs. at the same price per pound as an exactly similar pettit weighing 20 lbs. But this sort of thing would pass as soon as production got on a proper basis, because obviously it was wrong. It was easier to cast a pettit weighing 20 lbs. than one weighing 10 lbs. To all intents and purposes there was the same amount of workmanship, and to the moulder it made very little difference. What little difference there was was in favour of the heavier one. Similarly, wastage tended to be less with the heavier one so that everything was in favour of turning out the heavier pettit. But both were sold at the same price per pound, and there might be a case when it was really worth while to get the thinner one. If one had to buy them both at a real economical figure one would have to work it out. Then it would be a case of the load and of how long the pettit had to last.

He did not think it was right to mix creep stress with rate of oxidation. If one used 60 : 20 oxidation was fixed, and ultimately the component was going to break up because of the expansion and contraction, which in this industry was very fierce indeed. The pettits came out of the furnace, the unloading time was rapid. Then they were returned to the furnace to come out again in another quarter of an hour. This would disintegrate them. The thing to calculate was: "Shall we have a pettit that will not distort under the load, or have a thinner one, knowing that it will have to be straightened and will break more quickly than if not straightened?" All this was a matter of simple costing, which need not be done at present, because thick and thin pettits could be bought at the same price. But within a year or two this would cease to be the case, and the heavier pettit would come into its own.

Votes of Thanks

MR. ROBERTS (secretary of the Scottish Branch) proposed a vote of thanks. Aluminium-coated alloys, he said, were satisfactory for people doing wet coated work, but with dry dusting, enamel fell on the surface, and sooner or later it had to be blasted off. Unless it was recalorised it was useless. The Lecturer said that he had not heard of a muffle being constructed of heat-resisting alloy; but he (Mr. Roberts) had seen one, and he thought Mr. Kayser had explained the reason for its failure. Mr. Kayser was right in pointing out that the important consideration was not what a thing cost, but how it would turn out in the final result. Calculation would show that a little more expense in the beginning was justified.

MR. FRY seconded the resolution for a vote of thanks.

This was heartily accorded, and the LECTURER, having briefly acknowledged the compliment, the proceedings terminated.

Continuous Pouring of Ford Cylinder Blocks

Mr. Edwin F. Cone, writing in "Metal and Alloys," gives some interesting data as to the manufacture of cylinder blocks at the Ford plant at Dearborn. In the manufacture of cylinder blocks of cast iron, where as many as 6,000 to 6,500 a day must be turned out, it is at once realised that the solution of this problem is not an easy one. When operating at capacity, there are required about 850 tons of molten cast iron per day of 16 hrs. to produce the required number of cylinder blocks, while the total metal for foundry is 2,200 tons.

The first step in the assembling of the metal is to take molten pig-iron from one of the two Ford blast furnaces and place it in a 400-ton mixer with a definite quantity of cast iron from a battery of cupolas. The molten pig-iron is standard foundry iron. The metal from the cupolas is the result of melting some pig-iron with varying amounts of steel and iron scrap. The usual quantity of steel scrap is about 15 per cent., though larger percentages can be, and sometimes are, used. As high as 40 to 45 per cent. of pig-iron from the blast furnaces is not uncommon in charging the mixer.

At this point the composition of the metal in the mixer is definitely determined by analysis. Regulation of the proportions of blast-furnace and cupola iron are such that the composition desired is readily obtained. This composition, changed but very little by subsequent operations, is approximately as follows:—C, 3.15 to 3.35; Si, 1.8 to 2.1; Mn, 0.6 to 0.8; S, 0.1 max.; P, 0.25 to 0.32; Cu, 0.5 to 0.75 per cent.

The composition of the iron at the mixer having been determined as satisfactory, the hot metal is taken by means of a hot metal ladle to a 20-ton electric furnace, into which it is dumped. In this furnace the iron is superheated to about 1,444 deg. C., which has been determined as the suitable pouring temperature. The 20 tons are kept in the electric furnace from 20 min. to ½ hr.

In front of the electric furnace is a 25-ton specially-designed air furnace, fired with pulverised coal. Into this, at intervals of every 20 to 30 min., the hot metal flows by gravity from the electric furnace—not less than 40 tons an hr.

From the time the superheated metal leaves the electric furnace until it reaches the moulds there is no interruption in its flow. Ford engineers have perfected a novel apparatus which receives the metal as it flows in a trough from the air furnace—a movable pouring truck or ladle—which is so synchronised in its longitudinal and rotary motion that it receives metal continuously and discharges the metal intermittently to the moulds as they travel along beside the ladle truck on the mould-conveyor reel. There are two such streams of hot metal, one from each end of the air furnace, delivered by the two pouring trucks to two processions of moulds.

Thus two continuous streams—one of moulds and one of hot metal—meet at two central points. At each pouring station 115 moulds are poured per hr., each mould consuming about 315 lbs. of iron.

Production of Centrifugal Grey-Iron Castings in Water-Cooled Moulds*

By H. W. STUART,† Burlington, N.J., U.S.A.

Recently, it was discovered, by N. F. S. Russell and Dr. F. C. Langenberg, of the company with which the author is connected, that cast-iron pipe could be cast centrifugally without chill in steel moulds used in the DeLavaud process. The method by which this has been accomplished and the consequent improvement in the quality of the pipe, resulting from this discovery, will be presented in this Paper.

Operation of DeLavaud Casting Machine

Before describing the process by which chill-free pipes, called "super DeLavaud pipe," are cast in water-cooled steel moulds, it will be necessary to describe briefly the operation of a DeLavaud casting machine.

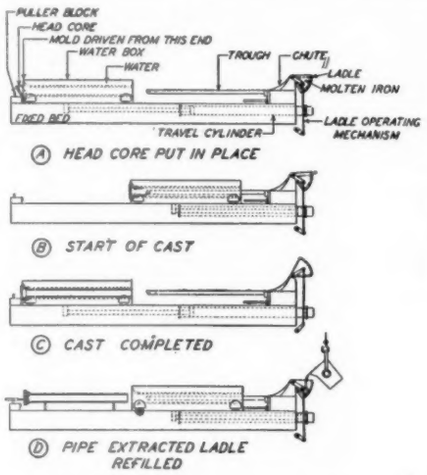


FIG. 1.—DELAVAUD CASTING MACHINE, SHOWING DIAGRAMMATICALLY THE OPERATIONS IN THE CASTING OF A CAST-IRON PIPE.

The DeLavaud casting machine, as shown purely diagrammatically in Fig. 1, consists essentially of a cylindrical steel mould, mounted on rollers in a water jacket, so that it can be rotated at comparatively high speeds by an electric motor. The water jacket also is mounted on wheels so that the entire assembly can be moved by a hydraulic cylinder in the direction of the longitudinal axis of the mould and on a fixed bed inclined slightly to the horizontal. The molten iron is fed into the mould through a trough, also slightly inclined to the horizontal. The trough has a spout, curved toward the side wall of the mould, at its lower end. Molten iron is supplied to the trough by a small ladle of sufficient capacity to make one pipe. In pouring, the ladle is tilted at a uniform rate by an electrically-operated tilting mechanism, thus maintaining a constant, uniform pouring rate.

In making bell-and-spigot pipe, it is necessary to insert a sand core into the bell end of the mould to form the inside contour of the pipe bell. This is done at the lower end of the fixed bed. Following that operation, the mould and its assembly are moved to the upper portion of the fixed bed.

When the mould is at the extreme upper end of the fixed bed, it is ready for casting, and the trough extends down the barrel for nearly its full length. After the tilting ladle has been filled by a transfer ladle from the cupola, the machine operator, stationed at the upper end of the machine, brings the mould up to speed and actuates the tilting ladle.

In a few seconds, the iron has filled the bell space and, when this is done, the core setter, stationed at the lower end of the machine, gives the operator a signal to start moving the mould longitudinally down the bed. The stream of iron discharged from the spout flows tangentially on to the surface of the mould, where it is held in place by centrifugal force and forms a homogeneous pipe. The hydraulic cylinder is supplied with a regulated amount of water at a constant pressure; therefore, the longitudinal movement of the mould is uniform. Since the speed of the tilting ladle and the amount of water supplied to the hydraulic cylinder can be regulated easily and accurately, the wall thickness of the pipe produced is held within the desired tolerances without difficulty.

After the spigot end of the mould has passed the pouring spout, any excess iron is directed into a pig mould, while the pipe mould is kept rotating at its original speed until the casting therein has cooled to approximately 815 deg. C. The casting is then extracted by anchoring it to the pulley block and withdrawing the mould. Having withdrawn the pipe, the mould is ready for the next casting. The entire operation requires from 2 to 10 min., depending upon the diameter and length of the casting. Pipes from 3 to 24 in. dia. and 12 and 18 ft. long are now being cast.

Development of Chill-Free Pipe

In 1930 a research department was established by the company with which the author is connected, and, shortly after this, it was found that, by altering the annealing cycle, the quality of the pipe was improved. It was further discovered that, to attain the impact resistance desired, a change in the casting method would have to be made.

The results of the tests conducted in the past indicated that if it were possible to produce a casting without the presence of chill, a greatly improved product would result. Knowing the cause of the chill and having determined that the basic principle of the process—use of water-cooled metallic moulds—was technically and economically sound, but one thing was left to be done. This was to provide a method for retarding the abstraction of heat from the molten metal.

A great deal of thought was given to the application of a refractory wash. There are, however, drawbacks attached to such a procedure. First, it would require a sufficiently long period between the application of the wash and the casting of the pipe to permit the wash to be dried thoroughly. Further, the wash would adhere to the pipe in some places and to the mould in others, with the result that the mould would have to be thoroughly cleaned and re-washed to obtain a pipe with a smooth surface. Attention, therefore, was turned to the possibility of applying a dry coating material to the surface of the mould which would either be completely removed with the casting or be of such nature that a jet of compressed air would quickly remove any residue of coating material from the mould.

Since cast-iron pipe must have a smooth outside surface, it was necessary to perfect a method by which pulverulent materials could be applied to the mould uniformly and conveniently. In addition, uniformity was necessary so that cooling of the molten metal would be retarded the same amount throughout the casting.

In perfecting a method for applying the pulverulent materials, a great deal of experimenting was required. Some of the early equipment for applying the pulverulent material was built very much on the salt-shaker principle. Other equipment consisted of a trough extending the full length of the mould, which contained the proper amount of coating material, and application and distribution were performed by tilting the trough containing the coating material while the mould was revolving. A screw conveyor which fed the powder through a tube fastened to the trough was also tried, but the nature of most of the pulverulent material is such as to pack very firmly and give the coated surface an unsatisfactory lumpy appearance.

Compressed Air as Carrier

When these mechanical means of distributing pulverulent material failed to produce the desired mould coating, compressed air was decided upon as a means of transporting and depositing a coating on the mould. In the use of compressed air as a carrier and a means of distribution, two problems were encountered. First, a means of feeding the pulverulent material into the air stream at a constant rate in regulated amounts had to be devised; second, a means of uniformly distributing the coating material over the mould surface was necessary.

Fig. 2 shows a device which was developed to feed regulated amounts of pulverulent

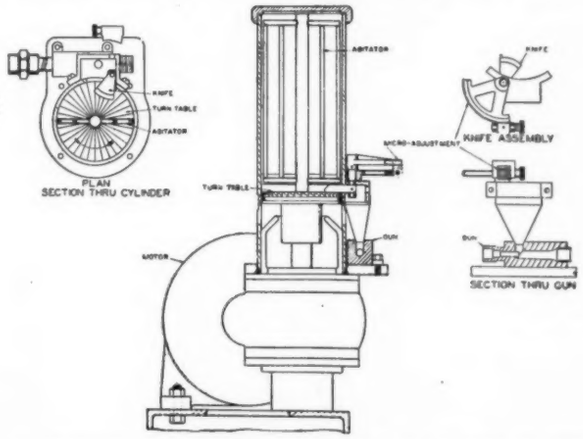


FIG. 2.—DEVICE DEVELOPED TO FEED REGULATED AMOUNTS OF PULVERULENT MATERIAL INTO THE AIR STREAM AT A CONSTANT RATE.

* Abstract of a Paper read before the Toronto meeting of the American Foundrymen's Association.

† The Author is connected with the United States Pipe & Foundry Company.

material into the air steam at a constant rate. This device consists of a cylinder, the bottom of which is a turn-table rotated at a uniform rate independently of the cylinder walls. The powder content of this cylinder is made to rotate as a unit by means of a centrally-located agitator and clutch teeth on the upper face of the turn-table. The cylinder is slotted at the top of the turn-table and a knife is affixed in the slot so that a constant amount of powder is pared from the uniformly-rotating column. This knife can be adjusted so that the amount of powder pared off can be varied from 20 to 1,200 grams per min. A funnel directs the powder delivered by the knife into an air jet. When the air expands, as it issues from the jet, it causes the powder to become suspended in the air stream. The mixture of gas and powder is conducted through a tube which forms an integral part of the casting-machine trough.

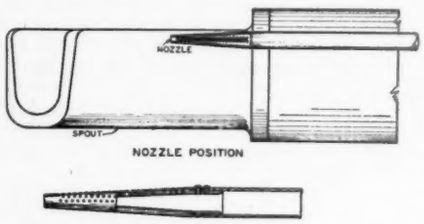


FIG. 3.—(TOP) DIAGRAM SHOWING THE POSITION OF NOZZLE IN RELATION TO POURING SPOUT. (BOTTOM) SECTION THROUGH NOZZLE.

To distribute the pulverulent material uniformly on the mould surface, the nozzle, shown in Fig. 3, was used. One hundred and fifty-seven different nozzle designs were tried before the tapered nozzle shown was adopted. The difficulty in obtaining the proper nozzle design was due to the fact that the suspended material had to be turned through 90 deg. and, at the same time, distributed over a length of approximately 3 in., so that the helix formed as it was applied to the mould would completely cover the surface.

Fig. 4 shows a DeLavaud machine in casting position with the equipment required to coat the main barrel of the mould. The feeding device at the upper end of the machine and the distributing nozzle, located just back of the trough spout, are connected by a steel tube that is an integral part of the trough. This equipment in no way interferes with the normal functioning of a DeLavaud casting operation, since the machine operator actuates the feeding device and air stream simultaneously with the longitudinal movement of the mould as the pipe is cast.

The very fine cloud of pulverulent material, which is clearly visible, is held against the inside surface of the mould by centrifugal force when the pipe is being cast.

The mould-coating equipment, shown in Fig. 4, cannot coat the bell portion of the mould due to the nozzle being behind the iron stream. Fig. 5 shows a portable air feeding device, and nozzle, which are used to coat this portion of the mould as the bell core is keyed in place. This operation is performed by the core-setter without interfering with the casting operation in any way.

As the method of applying a powder uniformly to a DeLavaud mould was being developed, progress was also being made in obtaining the proper mould-coating material to produce a chill-free pipe with a good surface. It was discovered early in the experiments with the use of air as a means of transporting and distributing the coating material, that chill-free pipe could be cast with a very small amount of coating material. For instance, a 12-in. dia., 18 ft. long pipe could be cast chill-free when only 200 grams of material were applied to the mould during the casting. About 150 times as much material was necessary to effectuate the same chill elimination if the mould coating was applied and distributed in accordance with previously known mechanical methods. The presence of large amounts of pulverulent coating material in a mould also has a very detrimental effect on the appearance of the pipe.

When 200 grams of ferro-silicon, one of the pulverulent materials used in this process, are applied to a mould for a 12-in. dia., 18-ft. long pipe, the film of powder is only 0.0003 in. thick. Such a thin film would not cause the outside surface or dimension to change a noticeable amount.

When a film of ferro-silicon 0.0003 in. thick is considered as a refractory, it is found that, as such, it would be wholly inadequate to retard the heat abstraction from the molten metal a sufficient amount to prevent the formation of chill. The effectiveness of this small amount of coating thus far is explainable only on the assumption that the particles of coating material, impelled by the carrier gas against the mould, are surrounded by an absorbed film of gas and that this film, for an appreciable time after the coating is deposited, forms an effective part of the coating and performs an important function in bringing about the absence of chill and a desirable structure in the casting.

(To be Concluded.)

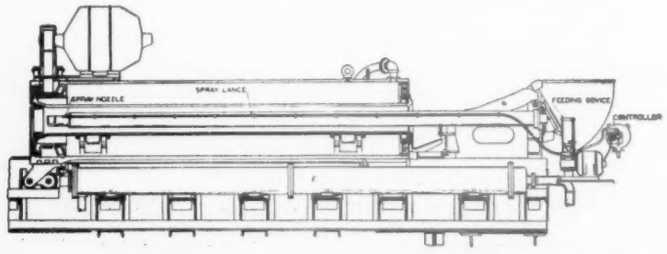


FIG. 4.—CASTING MACHINE IN POSITION, WITH EQUIPMENT NECESSARY FOR COATING THE MAIN BARREL OF THE MOULD.

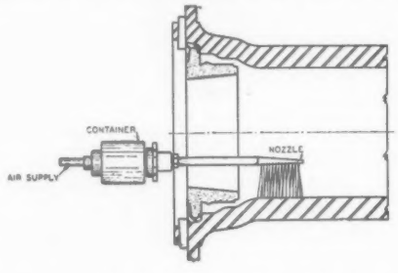


FIG. 5.—PORTABLE DEVICE FOR COATING THE BELL PORTION OF THE MOULD.

A PETITION presented to the High Court for the confirmation of the reduction of the capital of the Curtis Foundry & Engineering Company, Limited, from £20,000 to £5,038 will be heard before Mr. Justice Crossman on January 13.

French Exchange Paper

AUTHOR'S REPLY TO DISCUSSION

Owing to the sad death of one of the authors, Mr. Henri Fabre, the reply to the discussion on the French Official Exchange Paper to the Sheffield Conference of the Institute of British Foundrymen has been somewhat belated. Mr. Dubois writes to the effect that he thanks his colleagues in the Institute of British Foundrymen for the interest they have shown in the Paper written by the late Mr. Fabre and himself, and which was presented to the Sheffield Conference.

The discussion, which followed, showed that the foundryman's keenness for his profession is still strong. As was pointed out at the beginning of the Paper, it was only intended to give a few practical examples and to use the framework, thus given, as a basis for the fundamental information disclosed—that is, the study of process. To do more would have occupied far too much space. They could, thus, only defend their position by generalities, for their object was to popularise the principles of strickle moulding by illustrating it under diverse conditions.

The most important observations arising in the discussion were principally related to the moulding of the black pot. This was most interesting, since, with this particular case, one could include every case of moulding of containers. The precautions to take, in order to get good results from these castings, are to a large extent independent of their weight and size.

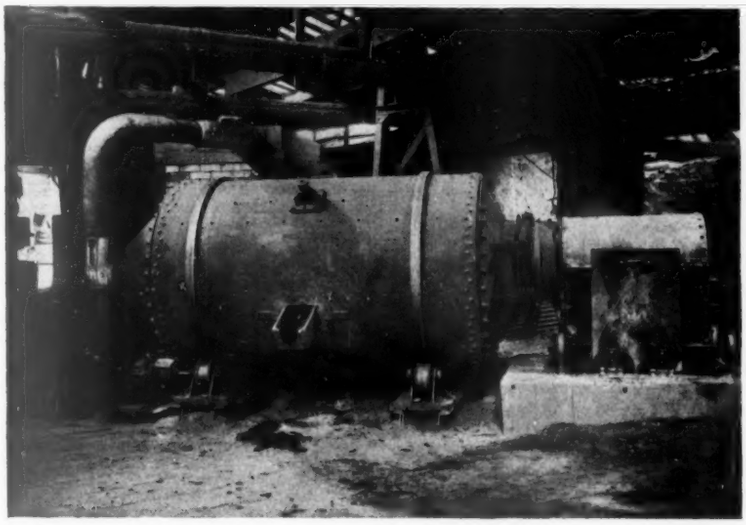
(1) *Is a single layer of bricks sufficient for the upper part of the core?* Practice confirms that this is so. Brickwork carried out in the manner indicated in the Paper is, because of the shape of the mould, exceedingly strong. In the case of rectangular containers, this strength should be reinforced by the ramming of sand in the interior of the core when assembling.

(2) *Arrangement of the Runners for the Black Pot.*—A very important fact should here be noted. It is that containers of this type are destined for the chemical industry and that their use must satisfy a large number of operations in industrial chemistry. It is thus essential to obtain castings free from porous or segregated parts. A casting made in special corrosion-resisting iron must be definitely homogeneous and be free from zones liable to set up premature corrosion. To fulfil these conditions, the runner feeding directly into the mould cavity has given, up to now, the best results. The casting is run from a circular filter basin, placed on the upper part of the mould and forms numerous channels of which the total section corresponds to the calculation that has been outlined in the Paper. The basin being kept full from the start, there is no need to fear the introduction of slag, which can be incorporated with the core, and will thus set up zones of corrosion and, consequently, cause the rejection of the casting.

(3) *Contraction.* — Special precautions are taken to avoid the results of contraction. They should be the greater, as the metal gives higher contraction than that of ordinary iron—about 15 millimetres. The annular plates, which form the armature of the core, should have, in the case of castings of large diameter, a diameter of at least 20 centimetres less than that of the castings. At the same time, the thickness of the layer of loam, which surrounds the bricks, should be adequate. However, if care is taken to place at 120 deg., along the top of the core, three rows of loam bricks, which can be taken away by knocking off after casting, and in

(Concluded on page 16.)

* FOUNDRY TRADE JOURNAL, July 11, 1935, p. 34, *et seq.*



1790 - 1936

Messrs. Edward Lucas & Son, Ltd., of Dronfield, were established in 1790 as Malleable Ironfounders. In 1933 they installed the latest and most economical type of melting plant—the 2-ton capacity **STEIN OIL-FIRED ROTARY FURNACE** Shewn here.

STEIN & ATKINSON, LTD.
47, VICTORIA STREET, LONDON, S.W.1.

WARNER Special PIG IRONS

- Warner C.B.R.
and
- Low Carbon Cylinder
(FOR CYLINDERS, ROLLS, ENGINEERING CASTINGS, ETC.)
- Low Carbon Malleable
(FOR MALLEABLE CASTINGS OF ALL DESCRIPTIONS)

Supplied to any specification between limits of 2·00 and 3·50% Carbon and ·50% and 3·50% Silicon

ACTUAL ANALYSIS CERTIFICATES ARE AVAILABLE WITH EACH DELIVERY

● **Typical Cylinder Pig Iron Specification**

TOTAL CARBON	2·70%
SILICON	1·80%
MANGANESE	·90%
SULPHUR	·06%
PHOSPHORUS	·40%

● **Typical Malleable Pig Iron Specification**

TOTAL CARBON	2·60%
SILICON	·75%
MANGANESE	·50%
SULPHUR	·05%
PHOSPHORUS	·06%

WARNER & CO., LTD.
CARGO FLEET MIDDLESBROUGH

This Week's News in Brief

Trade Talk

THE STAFF OF Qualcast, Limited, of Derby, held their Christmas carnival dance recently. Over 80 people were present.

THE STAVELEY COAL & IRON COMPANY'S foundry department recently held their annual social. About 350 people were present, and after supper there was a whist drive and dance.

OWING TO PRESSURE OF WORK at Messrs. John Brown's shipyard, Clydebank, the usual New Year holiday has been curtailed from ten days to one of three and a-half days. This is the shortest holiday in the history of the shipyard.

THERE WAS AN ATTENDANCE of 800 at the annual dance of the staff of the Hammond Lane Foundry Company, Dublin. The guests included the Lord Mayor of Dublin and Mr. David Frame, the chairman and managing director of the company.

PETITIONS FOR THE EXTENSION of premises at Carron Company's Mungal Foundry were passed this week by Falkirk Dean of Guild Court. The plans submitted showed an extension of the fitting shop of 132 ft. in length by 40 ft. in width, and also an extension of an existing store next to the patternshop.

MESSRS. GEORGE COHEN, SONS & COMPANY, LIMITED, have sold the goodwill of the Halley Motors, Limited, Glasgow, together with the whole of the spares, to Messrs. R. H. Collier & Company, Limited, South Yardley, Birmingham, who will continue to manufacture and supply all spares for every class of Halley vehicle.

WILLIAM DENNY & BROS., LIMITED, Dumbarton, have received an order from the L.M.S. Railway Company for a motor passenger vessel for service on Loch Awe. The vessel is to replace the steamer at present on that service. The new ship will be built at Dumbarton and taken in sections to Loch Awe, where it will be assembled.

SIR ERNEST W. PETTER, in the course of a review of the past year, published in "Petter's Monthly News," stated that if he, as an engineer, had to give points in a competitive tender for the purchase of machinery, he would apportion his marks somewhat as follows:—Reliability, including low cost of upkeep, 75; economy, 15; price, 10.

AT A MEETING of the Newcastle Branch of the Institute of British Foundrymen, held at the Neville Hall recently, the French Exchange Paper, entitled "The Strickle Moulding of Large Castings," by Mr. H. Fabre and H. Dubois, which was originally presented to the last annual conference of the Institute, and subsequently published in THE FOUNDRY TRADE JOURNAL, was read by Mr. J. W. Frier.

THE GOVERNMENT of India announces that, for duty purposes, British cast-iron fittings for cast-iron pipes and tubes will be admitted into the country either on a 10 per cent. *ad valorem* basis, or on payment of a specific duty, whichever is less. This step has been taken because the fall in prices has made the specific duty lower than the preferential *ad valorem* duty fixed for British imports under the Steel Protection Act.

THE WORKS of the Darlington Forge, Limited, one of the subsidiary companies of the English Steel Corporation, Limited, are to be reopened, it is officially stated at the Sheffield works of the Corporation. Early in the New Year a start will be made on the task of bringing the plant and equipment of the Darlington works into a thoroughly efficient state, the intention being to make them as modern as the Sheffield works of the Corporation.

AN ORDER for a motor vessel of about 1,000 tons gross has been placed with Messrs. A. & J. Inglis, Limited, Pointhouse Shipyard, Glasgow, by Messrs. William Robertson, shipowners, Glasgow. The new vessel will be similar in design to the "Sapphire," a motor coaster built this year by the Ailsa Shipbuilding Company, Troon, for Messrs. Robertson. The vessel will be fitted with "Polar" Diesel engines of the Atlas Diesel Company's standard design.

A NUMBER OF MEN from various departments of the Singer Factory at Clydebank are being sent out next week to the company's new factory near Paris. These men will be accompanied by some of the firm's key men, and will co-operate in initiating local labour into the production of sewing machines and accessories. All the necessary patterns and plant have been installed in the French factory, and production is planned to begin during the month.

CUTS MADE IN 1928 in the wages of men engaged in the light-castings industry are to be restored this year. An agreement has been reached between the employers and men. The increases will be as follow:—2s. 6d. per week to all piece-workers, 1s. 6d. per week to all time-workers, and 1s. per week to labourers. The apprentices' rates will be increased proportionately. The increases will affect approximately 33,000 workers throughout the country, including moulders, patternmakers, iron fitters, grinders, blacksmiths, and labourers. The restoration of the cuts will place wages on the 1925 level.

THE DIRECTORS OF Messrs. Cameron & Roberton, Limited, Southbank Ironworks, Kirkintilloch, on December 28, presented medals and a gift of money to eleven employees who had each completed 50 years' service with the firm. The men whose services were recognised in this way were Messrs. Patrick Docherty, William Gray, William Cluggie, Isaac Stark, James Cassels, Robert Walker, Peter Barr, Alex. Horne, William Graham, John McKechnie and Alex. Angus. A similar presentation was made to Mr. John Cameron, chairman of directors. Mr. T. P. Cameron, who made the presentation, complimented the men on their loyalty and service given to the firm.

A LECTURE WAS RECENTLY GIVEN by Mr. W. Astles, director of the Union Oxide & Chemical Company, Limited, on "Opacifiers Used in the Vitreous-Enamelling Industry," at Falkirk, and there was an attendance of about 40. Mr. James Jackson, of Jackson, Elphick & Company, Limited, took the chair. This lecture had already been given by Mr. Astles in London, and was published in THE FOUNDRY TRADE JOURNAL of November 7. Some enamelled exhibits were shown by the lecturer, covering the use of various opacifiers, and an interesting discussion took place, in which Mr. J. T. Gray, Mr. J. H. Gray, Mr. Jas. Jackson, Mr. J. G. Roberts and others took part. An important part of the discussion related to the use of zirconium oxide in both dry- and wet-process cast-iron enamelling, and also on sheet-iron enamelling, the discussion mainly dealing with the inert properties of zirconium and its non-reactivity with colours, and uniform firing conditions, producing freedom from black specks when this opacifier is utilised.

French Exchange Paper

(*Concluded from page* 14.)

addition the loam bricks at 120 deg. result in the production of a perfectly round casting.

(4) *Freeing the Core Gas.*—This is carried out in a very simple manner, since numerous vents are taken off between the bricks. The gas is lighted during casting, and, as a result, its evacuation is perfect.

(5) *Cost of Tackle.*—In the case of the moulding of a one-off job, the cost of tackle will, undoubtedly, be a very important item in the cost price; but it will always be lower than the cost of a complete pattern. On the other hand, as there are but a very few foundries specialising in loam moulding the amortisation of tackle is, as an actual fact, carried over to a large number of similar castings.

Finally, the author thanks his British colleagues for the questions they have asked, and he assures them that he is still at their disposal for any further information of which they may find themselves in need.

New Company

(*From the Register compiled by Jordan & Sons, Limited, Company Registration Agents, 116 to 118, Chancery Lane, London, W.C.2.*)

Hounslow Foundry, Limited.—New Road, Station Road, Hounslow, Middlesex. Nominal capital: £500. To carry on the business of metal founders, etc. Directors: M. G. Bryan, 127, Westway, Heston, Hounslow; R. W. Coley, 5, Bodley Road, New Malden, Surrey.

Personal

MR. W. FANNON, for many years foundry foreman at the Singer Sewing Machine factory, Clydebank, has retired after 45 years' service with the company. Mr. Fannon was with the firm when it moved from Bridgeton, Glasgow, to the more commodious site at Clydebank.

THE GOVERNORS of the Royal Technical College, Glasgow, have appointed Mr. William Kerr, Ph.D., to the chair of Civil and Mechanical Engineering and Applied Mechanics in succession to Prof. A. L. Mellanby, D.Sc., who is retiring under the rules of the superannuation scheme at the end of the current session.

MR. S. R. BEALE was unanimously elected chairman of Messrs. Guest, Keen & Nettlefolds, Limited, at a meeting of the directors recently. The deputy-chairman, Mr. T. S. Peacock, was unable to accept the chairmanship for reasons of health. Mr. Beale has been a director of Messrs. Guest, Keen & Nettlefolds since 1929. He is a younger brother of the late Sir John Field Beale, who had been chairman of the company from 1928. His father, Samuel Beale, was senior partner of Beale & Company, of London and Birmingham, solicitors to the Midland Railway Company. In addition to being on the board of Guest, Keen & Nettlefolds, Mr. Beale is a director of Messrs. Glenfield & Kennedy, Limited, Mavor & Coulson, Limited, Universal Grinding Wheel Company, Limited (chairman), and Worthington-Simpson, Limited. Since April, 1934, he has been President of the Association of British Chambers of Commerce.

Obituary

MR. JAMES A. WALLACE, who was for 32 years in the service of Messrs. Glenfield & Kennedy, Limited, as foundry clerk, died recently.

MR. REGINALD RICHARD JAMES, a partner in the firm of Messrs. Williams & James, manufacturers of air compressors and vacuum pumps, died recently.

MR. JOHN MCGREGOR, who has died at the age of 75, served with Messrs. Smith & Wellstood, Limited, Messrs. James Dougall & Sons, Limited, and Messrs. J. G. Stein & Company, Limited, being a departmental foreman with the two latter firms. He retired about eleven years ago.

MR. ANDREW CREE, who was for many years foundry foreman at the Queen's Park works of the North British Locomotive Company, Limited, died on December 17. Mr. Cree was well known in Scottish foundry circles, and in the early days of the Scottish Branch of the Institute of British Foundrymen did much useful propaganda work on its behalf.

Contracts Open

Emley, January 6.—Provision and laying of 2,600 lin. yds. of 4-in. dia. spun-cast iron pipes, for the Urban District Council. Mr. A. Brooksbank, 14, The Exchange, Bradford. (Fee £1 1s., returnable.)

Hampton, February 25.—Eight steam turbines with centrifugal pumps, electric generators, etc., for the Metropolitan Water Board. Chief Engineer's Department (Room 235), 173, Rosebery Avenue, E.C.1. (Fee £5 5s., returnable.)

Kirkburton, January 6.—Provision and laying of 2,226 yds. of 6-in. dia. cast-iron rising main, for the West Riding Mental Hospitals Board. Mr. W. E. H. Burton, engineer to the board, Mental Hospital, Wakefield.

Forthcoming Events

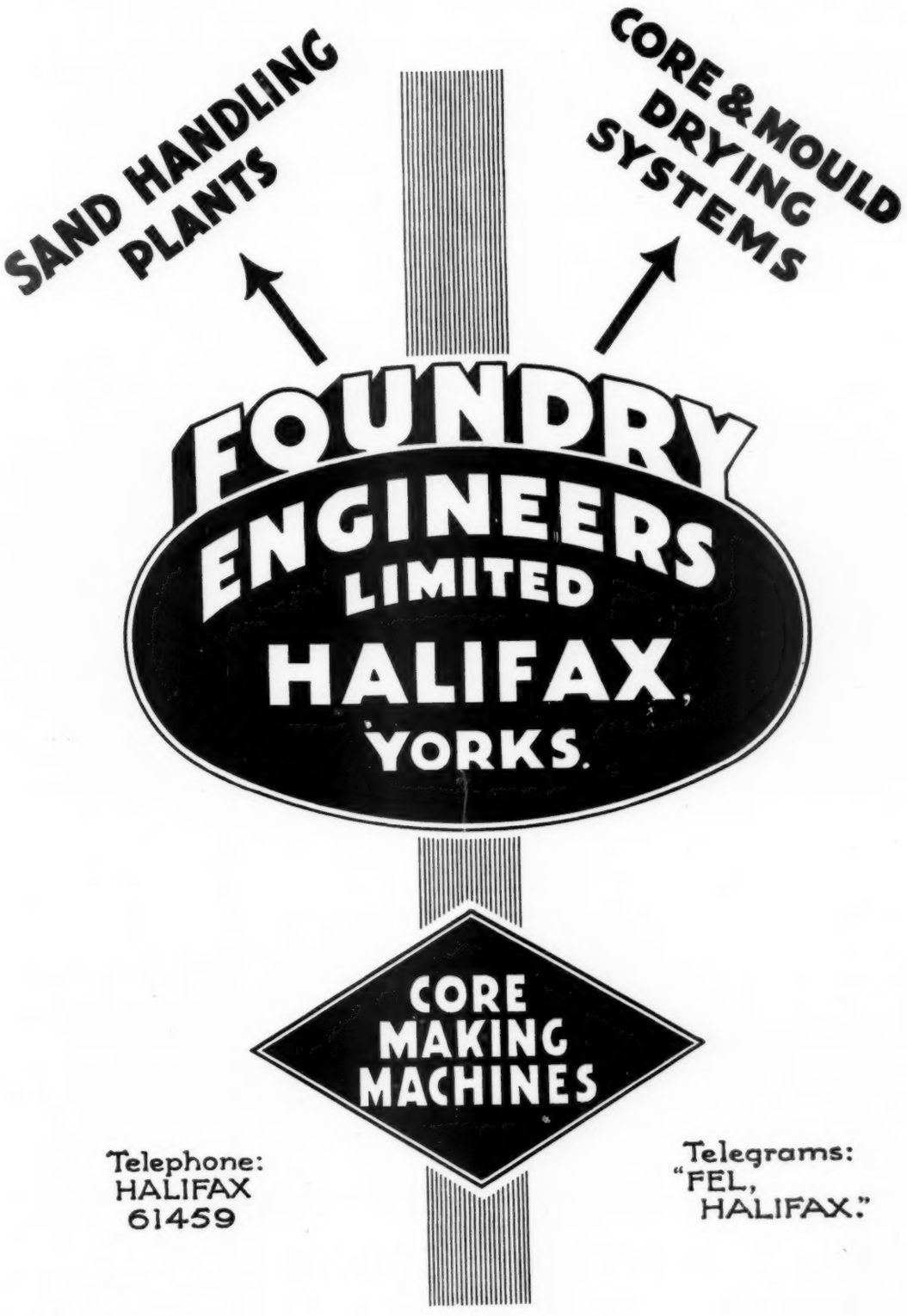
JANUARY 15.

Manchester Metallurgical Society (in association with the Institute of Metals):—Meeting at Engineers' Club, at 7 p.m. "Recent Developments in Alloy Steels," Paper by J. H. G. Monypenny.

The Institute of Vitreous Enamellers

JANUARY 2.

Manchester:—"Colouring Oxides and how they are affected by Variations of Enamel Composition." Paper by W. G. Ball, of the Blythe Colour Works, Limited, at the Y.M.C.A., Peter Street, Manchester, at 7.30 p.m.


SAND HANDLING PLANTS
CORE & MOULD DRYING SYSTEMS
FOUNDRY ENGINEERS LIMITED
HALIFAX, YORKS.
CORE MAKING MACHINES
Telephone: HALIFAX 61459
Telegrams: "FEL, HALIFAX."

Raw Material Markets

Business in the iron and steel trades has been limited during the past week, but a revival should be noticeable soon, although stocktaking will inevitably restrict the flow of business for a time. The threat of a national coal strike continues to be a source of anxiety to the iron and steel trades, though it is expected that negotiations between the miners and the owners will be brought to a satisfactory conclusion. Consumers continue to have heavy requirements and the pressure for deliveries of pig-iron and steel semis is considerable.

Pig-Iron

MIDDLESBROUGH.—Business on forward account is almost at a standstill in this area. The unsettled conditions prevailing in the coal industry have caused makers to refrain from entering into long-term contracts. The question of pig-iron prices is also proving a source of uncertainty in the market. It is thought that prices will be again advanced to cover the higher fuel costs. Deliveries continue to be on a good scale and have been only slightly reduced during the past week. Midlands iron is having to be utilised, both here and in Scotland, in order to relieve the position caused by the stringency of supplies of Cleveland iron. Prices are nominal, No. 3 Cleveland G.M.B. being quoted at 70s. per ton for delivery in the Middlesbrough and Falkirk areas, 72s. on the North-East Coast and 73s. on Clydeside, where Midlands iron is being offered at 71s. 9d.

Satisfactory conditions are reported by makers of East Coast hematite, who are keeping pace with their commitments. However, until next month, when the output is to be increased, there will be no surplus. As a result export business is not being invited. The rising costs of ore and fuel are giving the producers no option in the question of prices and an advance is probable before long. At the moment quotations remain unchanged, No. 1 East Coast hematite being at 71s. per ton delivered Middlesbrough, 72s. on Tyneside, 73s. 6d. for the North of England, 74s. in Scotland, 78s. 6d. in Sheffield, and 84s. 6d. in the Midlands.

LANCASHIRE.—Fairly satisfactory conditions prevail in this area, but the unsettled state of the cotton industry is a retarding factor. There has been a more regular flow of specifications for foundry iron for the machine-tool manufacturers, heavy electrical engineers, the light-castings makers, jobbing foundries, and both speciality and general engineers. In some cases firms have contracted for deliveries of iron over the first three months of 1936. Prices are firm. Quotations are on the basis of 78s. per ton for deliveries in the Lancashire zone of Derbyshire, Staffordshire and Lancashire brands of No. 3 foundry iron, 76s. 6d. for Northamptonshire, about 83s. for Scottish No. 3, 81s. for West Coast hematite, and from 80s. 6d. to 81s. for East Coast hematite.

MIDLANDS.—All grades of pig-iron are experiencing a very good demand and, following upon the increased cost of fuel and scrap, it is anticipated that an advance in values will be made shortly. Association prices delivered Birmingham and Black Country stations for Midland brands of common foundry iron remain at 72s. 6d. for Northants No. 3 and 75s. for Derbyshire, Lincolnshire and North Staffordshire No. 3, these figures being subject to a sliding scale rebate for large consumers. Special iron for the jobbing and general engineering trades continues to receive a good demand and prices, although not controlled, are very firm. Low-phosphorus pig-iron is between 89s. and 92s. 6d., medium-phosphorus 77s. 6d. to 87s. 6d., and refined pig-iron £5 15s. to £7 12s. 6d. per ton, delivered South Staffordshire. Most consumers of hematite are well covered, but the market is firm and some new business has been transacted recently. Prices are controlled and remain at £4 4s. 6d. for West Coast mixed numbers, £4 3s. 6d. for East Coast No. 3, and £4 3s. for Welsh mixed numbers, delivered Midland stations and plus 1s. 6d. per ton if delivered into works.

SCOTLAND.—The demand for Scottish pig-iron has been lessened during the past week by the New Year holidays, but the market remains firm. Stocks are low and, further, one blast furnace that has been making basic is being temporarily put out of action for repairs. At the present time there are only 13 blast furnaces in operation in this area, viz., five producing foundry, four on hematite and four on basic. Owing to the heavy call for supplies of steel-making irons it is generally anticipated that an increase in production will be made in the near future. Prices remain unchanged at the official minimum of 74s. f.o.t. furnaces for No. 3 foundry, with 2s. 6d. extra for No. 1. The light-castings makers continue to be well employed and in some cases holidays are being curtailed. The quotations for No. 3 Cleveland are unaltered at 70s. f.o.t. Falkirk, and 73s. f.o.t. Glasgow, with other English foundry irons quoted at 1s. 3d. per ton less. The steelworks are very busy and have heavy requirements in basic and hematite. Sellers are reluctant to commit themselves further and as a result the steelworks' orders are not all accepted. Current prices are:—Mixed numbers Scottish hematite, 73s. 6d.; mixed numbers West Coast hematite, 74s.; mixed numbers East Coast hematite, 74s.; basic, British and Indian, 70s. (less 5s. rebate), all f.o.t. steelworks here.

Coke

As a result of the recent advance in coal prices and the possibility of still further increases, the foundry coke market has been very active. Manufacturers are rather reluctant to sell and it is generally expected that further sharp increases will be made. For delivery in Birmingham and district best Durham coke is quoted at between 41s. 6d. and 43s., and Welsh from 36s. to 47s. 6d. per ton. Owing to the heavy call for Scottish coke nearer at hand no supplies are being offered at the present time.

Steel

Holiday influences have prevailed for the past week in the steel market, although in many districts the works continued in operation throughout the break, says the official report of the London Iron and Steel Exchange. On the resumption of business this week a good volume of inquiry was put into circulation, but comparatively few actual orders were transacted. The producers are entering the New Year with exceptionally well-filled order-books and are not disposed to undertake commitments until the coal position becomes clearer. The possibility of an advance in prices resulting from increased production costs arising from dearer fuel and other raw materials is also tending to hold up business. Stringent conditions continue to rule in the semi-finished steel market, and the producing works are unable to keep pace with the demand. In the finished-steel department also many of the steelworks are behind with deliveries, and in some sections are operating at capacity.

Scrap

Business in the Cleveland area has been practically uninterrupted by the holidays. There continues to be a heavy demand for supplies of heavy steel scrap and works are willing to pay 55s. per ton, or even a little more, but the material is still rather scarce. Machinery metal in handy sizes is receiving offers of 60s. per ton, while ordinary foundry cast-iron scrap is at 57s. 6d. and upwards. Clean, light cast iron is scarce and offers are between 46s. 6d. and 47s. 6d. Conditions on the Midland market continue to be steady, with a good demand for all qualities. Heavy steel scrap in furnace sizes is at 52s. 6d. and mixed heavy iron and steel 50s. Short, heavy, steel scrap as used in the foundries is quoted at 60s., delivered works. On the Scottish market conditions remain satisfactory. Heavy machinery cast-iron scrap, in pieces not exceeding 1 cwt., is in short supply, and is quoted around 62s. 6d. to 63s. 6d. Good, clean, heavy, ordinary cast-iron scrap, to the same specification, is about 57s. 6d., while heavy steelworks' cast iron is being quoted around 50s. to 52s. 6d. per ton, delivered f.o.t. consumers' works.

Metals

The Metal Exchange was closed on New Year's Day. Trading in the base metals has been on quiet lines, and generally only minor fluctuations in prices have been seen.

Copper.—Business in this market has been quiet during the past week, but quotations have been steady. Buying has been on a small scale in this country, but this was to be expected in view of the holidays and the annual stocktaking. The steady inquiry from Italy which was noticeable prior to the vacation has not yet been resumed. In the United States, new business is only on a moderate scale. It is anticipated in some quarters that the price will be raised from 9.25 cents per lb. to 9.50 cents. Development in the industrial section will largely govern this move. Sales of domestic copper in the United States during December are estimated to total 40,000 tons, compared with 31,914 tons in the previous month.

Daily market prices:—

Cash.—Friday, £35 1s. 3d. to £35 2s. 6d.; Monday, £34 18s. 9d. to £35 1s. 3d.; Tuesday, £35 to £35 2s. 6d.

Three Months.—Friday, £35 8s. 9d. to £35 11s. 3d.; Monday, £35 7s. 6d. to £35 8s. 9d.; Tuesday, £35 8s. 9d. to £35 10s.

Tin.—Quiet conditions have prevailed in this market, but prices have been fairly steady. Demand on the part of consumers has shown an expected decrease recently. Similar conditions have ruled on the Continent and in the United States. At the end of November of this year, world visible stocks amounted to 15,332 tons, or, approximately, 11 per cent. of the current annual rate of consumption. Other figures taken from the December issue of the bulletin of the International Tin Research and Development Council, issued by the Hague Statistical Office, give the world output of tin in October last as 15,068 tons, against 10,240 tons in September, 1935, and 8,638 tons in October, 1934. In the year ended October world output has increased by over 25 per cent. to 129,514 tons.

Metal Exchange quotations were as follow:—

Cash.—Friday, £217 10s. to £218; Monday, £217 15s. to £218 10s.; Tuesday, £218 to £218 5s.

Three Months.—Friday, £208 5s. to £208 10s.; Monday, £208 to £208 5s.; Tuesday, £208 to £208 5s.

Spelter.—This market continues to be very depressed and prospects for the early part of the New Year cannot be viewed with any degree of satisfaction. The undertone remains firm, but the market requires a strong stimulus before any real improvement can be expected. Conditions in the United States have become firmer during the past week and it would not be surprising were higher quotations to result.

Official quotations were as follow:—

Ordinary.—Friday, £14 12s. 6d.; Monday, £14 8s. 9d.; Tuesday, £14 11s. 3d.

Lead.—Prices in this market have further declined owing to the lack of interest by consumers during the holiday period. This setback should only be of a temporary nature and prospects for 1936 seem favourable. According to preliminary figures issued by the American Bureau of Metal Statistics, the world's output of lead in November was 148,100 short tons, compared with only 131,300 tons in the previous month. The United States produced 36,200 tons in November as against 37,800 tons in October.

Day-to-day quotations:—

Soft Foreign (Prompt).—Friday, £15 17s. 6d.; Monday, £15 8s. 9d.; Tuesday, £15 12s. 6d.

Industrial Welfare Society

In view of the success of its recent course of lectures on industrial law, the Industrial Welfare Society is arranging a similar course to be held weekly on Wednesdays from January 22, at the headquarters of the Society, 14, Hobart Place, Westminster, S.W.1 (2 minutes from Victoria Station). The lecturer will again be Mr. H. Samuels, M.A., barrister-at-law. The course is intended for all persons engaged in administrative work in industry and commerce, as well as for persons intending to take up such posts. The object of the course is to give those taking it a knowledge of those branches of the law which they will need in their work, treated as far as possible from a practical rather than an academic standpoint. Each lecture begins at 6.30 p.m. and lasts one hour. A further half hour is given to questions and discussion. The subjects treated include the history of industrial law, the law of master and servant, the Factory Acts, Employers' Liability and Workmen's Compensation, the law of trade unions and associations, national insurance, taxation and rating law, pension funds and other forms of welfare, elements of company law and the law relating to shops. A detailed syllabus and further particulars can be obtained on application to the Secretary, Industrial Welfare Society (Incorporated) 14, Hobart Place, Westminster, S.W.1.

WM. CUMMING & CO. LTD.

Established 1840.

The Leading Manufacturers!
The Oldest Established!!
The Most Reliable!!!

Ironfounders' Facings Manufacturers and General Foundry Furnishers,

Kelvinvale Mills, Maryhill, GLASGOW

Branches at Falkirk, Chesterfield, Deepfields and Middlesbrough

SUPERFINE COAL DUST

SUPERLATIVELY REGULAR IN GRIST.
SUPERIOR IN QUALITY.
SEVEN GRISTS STANDARDISED.
ONE QUALITY OF COAL THROUGHOUT.

INGOT MOULD BLACKING

THE BEST ON THE MARKET.
MANUFACTURED BY THE NEW PROCESS.

BRITISH PLUMBAGOS

AT LOW PRICES.
IMPORTED DIRECT.
NO CONTINENTAL ADULTERATION.

POWDERED CORE GUM

BRITISH MANUFACTURE.
BEST QUALITY.

CUMMING FURNACE

USERS OF THE NEW "CUMMING" FURNACE ARE INCREASING WEEK BY WEEK.

CORE COMPOUNDS, PARTINGS, CUMMINGSTONE, REQUISITES, BLACKINGS for every PURPOSE

ALL OUR OWN MAKE

RAW MATERIALS—PRICE LIST

(Wednesday, January 1, 1936)

COPPER*

	£	s.	d.
Standard cash	35	0	0
Three months	35	8	9
Electrolytic	39	5	0
Tough	37	10	0
Best selected	38	0	0
Sheets	66	0	0
India	49	0	0
Wire bars	39	15	0
Ingot bars	39	15	0
H.C. wire rods	43	5	0
Off. av. cash, Dec.	35	2	8½
Do., 3 mths., Dec.	35	11	1½
Do., Sttlmnt., Dec.	35	2	9
Do., Electro, Dec.	39	11	3
Do., B.S., Dec.	38	15	10
Do., wire bars, Dec.	39	16	3
Solid drawn tubes			10½d.
Brazed tubes			10½d.
Wire			6½d.

BRASS

Solid drawn tubes	9½d.
Brazed tubes	11½d.
Rods, drawn	8½d.
Rods, extd. or rlld.	5d.
Sheets to 10 w.g.	7½d.
Wire	7½d.
Rolled metal	7½d.
Yellow metal rods	5d.
Do. 4 × 4 Squares	5½d.
Do. 4 × 3 Sheets	5½d.

TIN*

	£	s.	d.
Standard cash	218	0	0
Three months	208	0	0
English	218	0	0
Bars	219	0	0
Straits	221	0	0
Australian	218	0	0
Eastern	215	0	0
Banca	219	0	0
Off. av. cash, Dec.	220	5	6¾
Do., 3 mths., Dec.	210	2	0
Do., Sttlmt., Dec.	220	3	9

SPELTER*

	£	s.	d.
Ordinary	14	11	3
Remelted	13	5	0
Hard	12	0	0
Electro 99.9	16	11	3
English	15	12	6
India	13	10	0
Zinc dust	19	10	0
Zinc ashes	4	15	0
Off. aver., Dec.	15	3	8¼
Aver. spot, Dec.	15	1	9¾

LEAD*

	£	s.	d.
Soft foreign ppt.	15	12	6
Empire (nom.)	16	7	6
English	17	15	0
Off. average, Dec.	16	16	3¾
Average spot, Dec.	16	16	0¾

ALUMINIUM

Ingots	£100 to £105
Wire	1/1 to 1/9 lb.
Sheet and foil	1/2 to 2/9 lb.

ZINC SHEETS, &c.

	£	s.	d.
Zinc sheets, English	22	12	6
Do., V.M. ex-whse.	23	17	6
Rods	27	15	0

ANTIMONY

	£	s.	d.
English	76 0 0 to 77	0	0
Chinese, ex-whse.	64	0	0
Crude, c.i.f.	32	10	0

QUICKSILVER

	£	s.	d.
Quicksilver	12 7 6 to 13	0	0

FERRO-ALLOYS AND STEEL-MAKING METALS

Ferro-silicon—	
25%	8 17 6
45/50%	12 15 0
75%	17 17 6
Ferro-vanadium—	
35/50%	12/8 lb. Va.
Ferro-molybdenum—	
70/75% carbon-free	4/6 lb. Mo.
Ferro-titanium—	
23/25% carbon-free	9d. lb.
Ferro-phosphorus, 20/25%	£18 0 0 to £20 0 0
Ferro-tungsten—	
80/85%	3/- lb.
Tungsten metal powder—	
98/99%	3/3 lb.
Ferro-chrome—	
2/4% car.	21 15 0
4/6% car.	21 0 0
6/8% car.	21 0 0
8/10% car.	21 0 0
Ferro-chrome—	
Max. 2% car.	33 10 0
Max. 1% car.	36 5 0
Max. 0.70% car.	37 5 0
70%, carbon-free	9½d. lb.
Nickel—99.5/100%	£200 to £205
"F" nickel shot	£184 0 0
Ferro-cobalt, 98/99%	5/6 lb.
Metallic chromium—	
96/98%	2/5 lb.
Ferro-manganese (net)—	
76/80% loose	£10 15 0 to 11 5 0
76/80% packed	£11 15 0 to 12 5 0
76/80% export	(nom.) £9 15 0
Metallic manganese—	
94/96% carbon-free	1/3 lb.

Per ton unless otherwise stated.

HIGH-SPEED TOOL STEEL

Finished bars, 14% tungsten 2s. 0d.
Finished bars, 18% tungsten 2s. 9d.
Per lb. net, d/d buyers' works.

Extras—
Rounds and squares, 3 in. and over 4d. lb.
Rounds and squares, under ½ in. to ¼ in. 3d. lb.
Do., under ¼ in. to $\frac{3}{16}$ in. 1/- lb.
Flats, ½ in. × ¼ in. to under 1 in. × ⅛ in. 3d. lb.
Do., under ½ in. × ¼ in. 1/- lb.
Bevels of approved sizes and sections 6d. lb.
Bars cut to length, 10% extra.

SCRAP

	£	s.	d.	£	s.	d.
South Wales—						
Heavy steel	3	2	6	to 3	5	0
Mixed iron and steel	2	17	6	to 3	0	0
Heavy cast iron				2	15	0
Good machinery	2	17	6	to 3	0	0
Cleveland—						
Heavy steel				2	15	0
Steel turnings				1	17	6
Cast-iron borings				1	7	6
Heavy cast iron				2	17	6
Heavy machinery				3	0	0
Midlands—						
Light cast-iron scrap				2	7	6
Heavy wrought iron	3	2	6	to 3	5	0
Steel turnings	1	17	6	to 2	0	0
Scotland—						
Heavy steel				2	12	6
Ordinary cast iron				2	17	6
Engineers' turnings				2	0	0
Cast-iron borings	1	17	6	to 1	18	6
Wrot-iron piling				3	5	0
Heavy machinery	3	2	6	to 3	3	6

London—Merchants' buying prices, delivered yard.

	£	s.	d.
Copper (clean)	29	0	0
Brass	19	0	0
Lead (less usual draft)	15	10	0
Tea lead	12	0	0
Zinc	9	0	0
New aluminium cuttings	72	0	0
Braziery copper	26	0	0
Gunmetal	27	0	0
Hollow pewter	150	0	0
Shaped black pewter	115	0	0

PIG-IRON

N.E. Coast (d/d Tees-side area)—

Foundry No. 1	72/6
Foundry No. 3	70/-
,, at Falkirk	70/-
,, at Glasgow	73/-
Foundry No. 4	69/-
Forge No. 4	69/-
Hematite No. 1	71/-
Hematite M/Nos.	70/6

N.W. Coast—

Hem. M/Nos. d/d Glas.	74/-
,, d/d Birm.	84/6
Malleable iron d/d Birm.	115/-

Midlands (d/d Birmingham dist.)—

Staffs No. 4 forge	71/-
,, No. 3 fdry.	75/-
Northants forge	68/6
,, fdry. No. 3	72/6
,, fdry. No. 1	75/6
Derbyshire forge	71/-
,, fdry. No. 3	75/-
,, fdry. No. 1	78/-

Scotland—

Foundry No. 1, f.o.t.	76/6
,, No. 3, f.o.t.	74/-
Hem. M/Nos. d/d	73/6

Sheffield (d/d district)—

Derby forge	68/6
,, fdry. No. 3	72/6
Lincs forge	68/6
,, fdry. No. 3	72/6
W.C. hematite	86/-

Lancashire (d/d eq. Man.)—

Derby fdry. No. 3	78/-
Staffs fdry. No. 3	78/-
Northants fdry. No. 3	76/6
Cleveland fdry. No. 3	78/-
Dalzell, No. 3 (special)	102/6 to 105/-
Glengarnock, No. 3	83/-
Clyde, No. 3	83/-
Monkland, No. 3	83/-
Summerlee, No. 3	83/-
Eglinton, No. 3	83/-
Gartsherrie, No. 3	83/-
Shotts, No. 3	83/-

FINISHED IRON AND STEEL

Usual district deliveries for iron; delivered consumer's station for steel.

Iron—	£	s.	d.	£	s.	d.
Bars (cr.)	9	12	6	to 9	15	0
Nut and bolt iron	7	17	6	to 8	7	6
Hoops	10	10	0	and up.		
Marked bars (Staffs) f.o.t.		12	0	0		
Gas strip		10	10	0	and up.	
Bolts and nuts, ¾ in. × 4 in.		15	5	0	and up.	
Steel—						
Plates, ship, etc.	8	15	0	to 8	17	6
Boiler plts.	9	5	0	to 9	7	6
Chequer plts.				10	7	6
Angles				8	7	6
Tees				9	7	6
Joists				8	15	0
Rounds and squares, 3 in. to 5½ in.				9	7	6
Rounds under 3 in. to ½ in. (Untested)				8	12	0
Flats—8 in. wide and over				8	12	6
,, under 8 in. and over 5 in.				8	17	6
Rails, heavy	8	5	0	to 8	10	0
Fishplates	12	5	0	to 12	10	0
Hoops (Staffs)				9	7	0
Black sheets, 24g. (4-t. lots)				11	10	0
Galv. cor. shts. (,,)				13	10	0
Galv. flat shts. (,,)				14	0	0
Galv. fencing wire, 8g. plain				14	10	0
Billets, soft	5	10	0	and up.		
Billets, hard	6	17	6	to 7	2	6
Sheet bars	5	10	0	to 5	15	0
Tin bars	5	10	0	to 5	15	0

PHOSPHOR BRONZE

	Per lb. basis.
Strip	10½d
Sheet to 10 w.g.	11½d.
Wire	12½d.
Rods	11½d.
Tubes	14d.
Castings	12½d.

Delivery 3 cwt. free.
10% phos. cop. £30 above B.S.
15% phos. cop. £35 above B.S.
Phosphor tin (5%) £30 above price of English ingots.
C. CLIFFORD & SON, LIMITED.

NICKEL SILVER, &c.

	Per lb.
Ingots for raising	7d. to 1/1
Rolled—	
To 9 in. wide	1/1 to 1/7
To 12 in. wide	1/1½ to 1/7½
To 15 in. wide	1/1½ to 1/7½
To 18 in. wide	1/2 to 1/8
To 21 in. wide	1/2½ to 1/8½
To 25 in. wide	1/3 to 1/9
Ingots for spoons and forks	7d. to 1/3½
Ingots rolled to spoon size	10d. to 1/6½
Wire round—	
to 10g.	1/4½ to 1/11½

with extras according to gauge.
Special 5ths quality turning rods in straight lengths, 1/3½ upwards.

AMERICAN IRON AND STEEL

At Pittsburgh unless otherwise stated.

	Dols.
No. 2 foundry, Phila.	21.31
No. 2 foundry, Valley	19.50
No. 2 foundry, Birm.	15.50
Basic, Valley	19.00
Malleable, Valley	19.50
Grey forge, Valley	19.00
Ferro-mang. 80%, seaboard	75.00
O.-h. rails, h'y, at mill	36.37½
Billets	29.00
Sheet bars	30.00
Wire rods	40.00
	Cents.
Iron bars, Chicago	1.80
Steel bars	1.85
Tank plates	1.80
Beams, etc.	1.80
Skelp, grooved steel	1.80
Steel hoops	2.10
Sheets, black, No. 24	2.40
Sheets, galv., No. 24	3.10
Wire nails	2.40
Plain wire	2.30
Barbed wire, galv.	2.80
Tinplates, 100-lb. box	$5.25

COKE (at ovens)

Welsh foundry	25/- to 30/-
,, furnace	20/- to 22/-
Durham foundry	22/6
,, furnace	18/9 to 20/-
Scotland, foundry	28/-
,, furnace	25/-

TINPLATES

f.o.b. Bristol Channel ports.

I.C. cokes	20×14 per box	18/9 to 19/-
,,	28×20 ,,	37/6 to 38/-
,,	20×10 ,,	27/- to 28/-
,,	18¾×14 ,,	19/6
C.W.	20×14 ,,	15/9
,,	28×20 ,,	33/9
,,	20×10 ,,	23/-
,,	18¾×14 ,,	16/-

SWEDISH CHARCOAL IRON & STEEL

	£	s.	d.	£	s.	d.
Pig-iron	6	0	0	to £7	0	0
Bars-hammered, basis	£16	0	0	to £16	10	0
Bars and nail-rods, rolled, basis	£15	15	0	to £16	0	0
Blooms	£10	0	0	to £12	0	0
Keg steel	£30	0	0	to £31	0	0
Faggot steel	£18	0	0	to £23	0	0
Bars and rods dead soft, st'l	£10	0	0	to £12	0	0

All per English ton, f.o.b. Gothenburg
[Subject to an exchange basis of Kr. 18.16 to £1.]

* Tuesday's closing prices. The Metal Exchange was closed on New Year's Day.

DAILY FLUCTUATIONS

Standard Copper (cash)

	£	s.	d.	
Dec. 27 ..	35	1	3	No change
„ 30 ..	34	18	9	dec. 2/6
„ 31 ..	35	0	0	inc. 1/3
Jan. 1 ..	—		—	

Standard Tin (cash)

	£	s.	d.	
Dec. 27 ..	217	10	0	inc. 25/-
„ 30 ..	217	15	0	„ 5/-
„ 31 ..	218	0	0	„ 5/-
Jan. 1 ..		—		—

Spelter (ordinary)

	£	s.	d.	
Dec 27 ..	14	12	6	dec. 2/6
„ 30 ..	14	8	9	„ 3/9
„ 31 ..	14	11	3	inc. 2/6
Jan. 1 ..	—		—	

Zinc Sheets (English)

	£	s.	d.	
Dec. 27 ..	22	17	6	dec. 2/6
„ 30 ..	22	10	0	„ 7/6
„ 31 ..	22	12	6	inc. 2/6
Jan. 1 ..	—		—	

Electrolytic Copper

	£	s.	d.	
Dec. 27 ..	39	5	0	No change
„ 30 ..	39	5	0	„ „
„ 31 ..	39	5	0	„ „
Jan. 1 ..	—		—	

Tin (English ingots)

	£	s.	d.	
Dec. 27 ..	217	10	0	inc. 20/-
„ 30 ..	218	0	0	„ 10/-
„ 31 ..	218	0	0	No change
Jan. 1 ..	—		—	

Spelter (Electro, 99.9 per cent.)

	£	s.	d.	
Dec. 27 ..	16	15	0	dec. 1/3
„ 30 ..	16	8	9	„ 6/3
„ 31 ..	16	11	3	inc. 2/6
Jan. 1 ..	—		—	

Lead (English)

	£	s.	d.	
Dec. 27 ..	18	0	0	dec. 5/-
„ 30 ..	17	10	0	„ 10/-
„ 31 ..	17	15	0	inc. 5/-
Jan. 1 ..	—		—	

AVERAGE MONTHLY PRICES OF FURNACE COKE D/D MIDDLESBROUGH

Year.	January.	February.	March.	April.	May.	June.	July.	August.	September.	October.	November.	December.	Yearly average.
	£ s. d.	£ s. d.	£ s. d.	£ s. d.	£ s. d.	£ s. d.	£ s. d.	£ s. d.	£ s. d.	£ s. d.	£ s. d.	£ s. d.	£ s. d.
1903	0 15 9	0 16 0	0 16 3	0 16 9	0 16 6	0 16 3	0 16 0	0 15 9	0 15 6	0 15 0	0 14 6	0 14 0	0 15 8½
1904	0 13 9	0 13 9	0 13 3	0 14 3	0 14 6	0 14 3	0 14 3	0 14 3	0 14 3	0 14 0	0 14 0	0 14 6	0 14 1½
1905	0 14 9	0 15 3	0 15 3	0 15 3	0 15 6	0 15 6	0 15 6	0 15 6	0 15 6	0 15 6	0 15 9	0 17 0	0 15 5½
1906	0 17 6	0 17 6	0 17 0	0 17 0	0 17 0	0 16 6	0 17 0	0 17 0	0 18 3	0 18 6	0 19 0	1 0 0	0 17 8½
1907	1 4 6	1 5 0	1 5 0	1 0 6	1 2 0	1 1 0	1 1 0	1 1 0	1 2 0	1 1 6	1 0 0	0 17 0	1 1 8½
1908	0 16 0	0 16 0	0 15 6	0 16 0	0 16 3	0 16 0	0 15 6	0 15 6	0 15 6	0 15 3	0 16 0	0 16 0	0 15 9½
1909	0 16 0	0 15 3	0 15 0	0 14 9	0 15 6	0 15 9	0 15 6	0 15 6	0 16 6	0 17 0	0 17 6	0 17 0	0 15 11½
1910	0 18 4½	0 18 6½	0 18 0	0 18 0	0 17 10½	0 17 0	0 16 1½	0 15 9½	0 15 11	0 16 0	0 15 9½	0 15 8	0 16 11
1911	0 16 0	0 15 10½	0 15 6	0 15 3	0 14 9	0 14 6	0 14 6	0 14 6	0 14 6	0 14 11½	0 15 0½	0 16 3½	0 15 1½
1912	0 17 3	0 17 3	0 18 6	0 18 10	0 19 0	0 19 4½	0 19 10½	1 0 9½	1 2 9	1 4 1½	1 5 8½	1 8 6	1 1 0
1913	1 5 9	1 4 11	1 5 0	1 5 0	1 4 9½	1 0 4½	0 19 5½	0 18 3	0 18 0	0 18 2½	0 18 6	0 18 6	1 1 4½
1914	0 18 2	0 17 1	0 17 0	0 17 0	0 17 4	0 17 6	0 17 6	0 18 5	0 18 4	0 17 9	0 17 6	0 18 5	0 17 8
1915	0 17 10½	0 17 9	1 0 4½	1 7 7½	1 9 4½	1 10 7½	1 9 7	1 7 3	1 5 4	1 4 9	1 9 6	1 13 0	1 6 1
1916	1 10 9	1 10 6	1 10 6	1 10 6	1 10 6	1 10 6	1 10 6	1 10 6	1 10 6	1 10 6	1 10 6	1 10 6	1 10 6½
1917	1 10 6	1 10 6	1 10 6	1 10 6	1 10 6	1 10 6	1 10 6	1 10 6	1 10 6	1 10 6	1 14 3	1 15 6	1 11 2½
1918	1 15 6	1 15 6	1 15 6	1 15 6	1 15 6	1 15 6	1 15 6	1 15 6	1 15 6	1 15 6	1 15 6	1 15 6	1 15 6
1919	1 15 6	1 15 6	1 15 6	1 15 6	2 1 6	2 1 6	2 3 9	2 10 6	2 10 6	2 10 6	2 10 6	2 10 6	2 3 5
1920	2 12 3	2 14 0	2 19 0	2 19 0	3 3 8	3 6 0	3 6 0	3 6 0	3 6 0	3 6 0	3 6 0	3 6 0	3 2 6
1921	3 1 0½	2 19 0	2 16 0	2 7 0	2 6 6	2 6 6	2 0 6	2 0 0	1 13 11	1 12 9	1 10 4½	* 8 3	2 3 6½
1922	1 7 0½	1 8 1½	1 9 7½	1 8 4½	1 7 11½	1 7 3	1 6 9½	1 6 10½	1 7 0½	1 10 2½	1 10 0	1 9 11½	1 8 3½
1923	1 11 3	1 14 6	2 0 1½	2 2 8½	2 4 4½	2 2 10½	2 1 0½	2 1 6	2 0 9½	1 18 9	1 18 8½	1 18 3	1 19 7½
1924	1 16 6½	1 14 9	1 11 11½	1 10 0½	1 8 1½	1 7 8½	1 7 3	1 6 3	1 6 0	1 5 0	1 5 0	1 5 0	1 9 5½
1925	1 4 10½	1 4 1½	1 13 3	1 2 4½	1 2 2½	1 1 5½	1 1 3½	1 4 9	0 18 10½	0 18 4½	0 19 6½	1 1 4½	1 2 8½
1926	1 2 1½	1 0 9	0 19 2½	0 18 6½	*	*	*	*	*	*	*	1 5 0	1 1 1‖
1927	1 5 6	1 4 9½	1 6 1½	1 3 9	1 2 6	1 0 8½	0 19 4½	0 19 0	0 18 7½	0 18 0	0 17 10½	0 17 6	1 1 1½
1928	0 17 6	0 17 10½	0 18 0½	0 17 11½	0 17 8½	0 17 6½	0 17 7½	0 17 6½	0 17 6	0 17 7½	0 17 7½	0 17 6	1 1 1½
1929	0 17 7½	0 18 0	0 19 0	0 19 6½	0 18 10½	0 19 10½	1 1 3½	1 1 8½	1 3 0	1 3 6	1 3 8	1 3 1½	1 0 9½
1930	1 2 6½	1 1 3	1 0 3	0 19 1½	0 17 7	0 16 10½	0 16 6	0 16 6	0 16 9	0 17 0	0 17 0	0 17 0	0 18 2½
1931	0 17 0	0 16 7½	0 16 0	0 16 0	0 15 11	0 15 5	0 15 1	0 15 0	0 15 0	0 16 9	0 17 0	0 16 6	0 16 0½
1932	0 17 0	0 16 11½	0 16 5½	0 15 9	0 15 7½	0 15 6	0 15 6	0 14 9½	0 14 6½	0 14 6	0 14 6	0 15 4	0 15 6½
1933	0 16 0½	0 15 11½	0 15 6½	0 15 6	0 15 6	0 15 6	0 15 6	0 15 8½	0 16 1½	0 17 0	0 17 6	0 18 9	0 16 1½
1934	0 19 1½	1 0 6	1 0 2	1 0 0	1 0 0	1 0 0	1 0 0	1 0 0	1 0 0	1 0 0	1 0 0	1 0 0	0 19 11½
1935	1 0 0	0 19 6½	0 19 0½	0 19 0	0 19 0	0 19 0	0 19 0	0 19 0	0 18 9½	0 18 9½	0 19 3½	1 1 2½	0 19 2½

* Strike period. ‖ Five months.

WILLIAM JACKS & COMPANY,

WINCHESTER HOUSE, OLD BROAD ST., LONDON, E.C.2.

CLARENCE CHAMBERS, 39, CORPORATION STREET, BIRMINGHAM.

13, RUMFORD STREET, LIVERPOOL.

PIG

IRON

All grades FOUNDRY, HEMATITE, BASIC, SPECIALS, &c.

NON-FERROUS METALS

COPPER, TIN, LEAD, SPELTER, ANTIMONY, CHROME ORE.

WILLIAM JACKS & COMPANY,

CENTRAL CHAMBERS, 93, HOPE ST., GLASGOW, C.2.

ZETLAND ROAD, MIDDLESBROUGH.

Notice

Small Advertisements in this section of the Journal are accepted at the prepaid rate of 6d. per line, first line in capitals counting two, average 6 words per line. Minimum charge for one insertion 3/-

(A remittance should accompany instructions.)

SITUATIONS VACANT AND WANTED

FOUNDRY FOREMAN, at present engaged in general engineering castings, desires change. Practical and technical education. Age 35.—Box 508, Offices of THE FOUNDRY TRADE JOURNAL, 49, Wellington Street, Strand, London, W.C.2.

FOUNDRY FOREMAN wanted for large ironfoundry, West Riding of Yorks. Castings up to 30 tons. Loam, dry sand and green sand. State age, experience, and salary required.—Box 522, Offices of THE FOUNDRY TRADE JOURNAL, 49, Wellington Street, Strand, London, W.C.2.

EMPLOYMENT REGISTER.

Conducted by the Institute of British Foundrymen by courtesy of the proprietors of THE FOUNDRY TRADE JOURNAL.

Correspondence should be addressed to the General Secretary, Institute of British Foundrymen, St John Street Chambers, Deansgate, Manchester, from whom full particulars can be obtained of this service.

Any employer wishing to communicate with a candidate should write to the General Secretary, quoting identification number.

IRONFOUNDRY Foreman working in Lancashire town seeks position with progressive firm; 36 years' experience in modern foundry practice; Midlands preferred. (270)

NOTICE

UNIVERSITY OF LEEDS.

DEPARTMENT OF COAL GAS AND FUEL INDUSTRIES (WITH METALLURGY).

SPECIAL courses of evening lectures will be given during January, February and March, as follow :—

THE MANUFACTURE OF COAL GAS—Mr. R. Dally, M.Sc., Mr. F. J. Dent, Ph.D., and Mr. H. Hollings, M.Sc., A.I.C.

REFRACTORY MATERIALS—Prof. J. W. Cobb, C.B.E., B.Sc., F.I.C., and Mr. A. L. Roberts, Ph.D.

ENGINEERING METALLURGY—Mr. A. Preece, M.Sc.

The Laboratory will be open on Wednesday evenings during January and February for students who have already received some chemical training, but who desire instruction in Fuel Calorimetry and Pyrometry.

Further information may be had from The Registrar, The University, Leeds 2.

MACHINERY

FOR SALE, Blacksmiths' Hearths, complete with Tuyeres; sizes 3′ x 3′; £5 each.—Apply E. HIND, Imperial Works, South Bank/Tees.

FOR SALE, Jackman No. 4 Cupola; rated capacity 6/7 tons; good condition; £75.—Apply E. HIND, LIMITED, Imperial Works, South Bank/Tees.

THOS. W. WARD LTD.

4″ Motor-driven BLOWER (Keith Blackman); 600 cub. ft. capacity p.m.; 8″ water gauge; 440 volts; 3,666 r.p.m.

Jar-ram Turnover MOULDING MACHINES (Ajax) for 19″ x 15″ boxes.

Three LANCS. BOILERS; 30′ x 8′; 140 lbs. w.p.

Two Steel DISH-ENDED RECEIVERS; 13′ 8″ long x 5′ dia.; 475 lbs. w.p.

Write for "Albion" Catalogue.

'Grams: "Forward." 'Phone: 23001 (10 lines).

ALBION WORKS, SHEFFIELD.

MACHINERY—*Continued*

NEW Dwarf Cupola, to melt 10 to 15 cwts. per hr. New Worm-geared Ladles, 5 tons, 25 cwts., 15 cwts. and 10 cwts. capacity. Ungeared Ladles, 15 cwts. and 10 cwts. capacity. Improved Cupola Spark Arresters.—T. DAVIES & SON, West Gorton, Manchester.

Tilghman Sandblast Barrel Plants; barrel sizes—60 in. x 40 in.; 36 in. x 20 in.; 20 in. x 30 in.

Tilghman Sandblast Cabinet Plants; 4 ft. 6 in. and 3 ft. 6 in. square (one for high pressure 70 lbs. per sq. in.); also small Cabinet 30 in. dia.

All complete with Air Compressors, etc.

Pneulec Royer Sand Thrower, size No. 1.

Six Osborne Pneumatic Jolt Press Moulding Machines, size 75J.

Three Mumford Yoke Headpress Pneumatic Moulding Machines.

Two Herbert Whizzer Sand Disintegrators.

Two Brealey Type ditto.

Heavy Double-ended Grinding Machines by Rowlands, Luke & Spencer, etc.

Hand Moulding Machines by Adaptable Darling & Sellars, Pridmore, Samuelson, etc.

500 Electric Motors, Dynamos, Rotary Converters, etc.

S. C. BILSBY, A.M.I.C.E., A.M.I.E.E.

CROSSWELLS ROAD (Adjoining Railway Crossing), LANGLEY, Nr. Birmingham.

'Phone: Broadwell 1359.

'Phone: 287 SLOUGH

SAND PLANT

Herbert Whizzer, large size. **£48.**
Brealey Disintegrator, NEW. **£23.**
Pneumatic Riddles, Jackman type. **£9 each.**

SANDBLAST PLANT

BARREL PLANT by Tilghman, *as new*, 60″×40″. Price **£240.**

NEW 8′×8′ ROOM PLANT, complete. Price **£230.**

CAST IRON ROOM PLANT, 12′×9′, complete with 400 cu. ft. motor-driven compressor for A.C. current, in new condition. Cheap.

Several small complete barrel plants in stock.

Genuine Evans 10-ton Crane Ladle. Price **£35.**

BUY FROM ME AND SAVE MONEY!

ALEX. HAMMOND, *Foundry Machinery Merchant,*
14, AUSTRALIA ROAD, SLOUGH

IDAHO PINE
YELLOW PINE

PRIME & PATTERN GRADES
¼″ to 3″ thick
Width up to 24″ wide
All free of centre heart and shake

CHETHAM TIMBER Co., Ltd.,
70, FINSBURY PAVEMENT, LONDON, E.C.2
Metropolitan 7418

MISCELLANEOUS

FOR A NEW YEAR GOOD RESOLUTION we suggest this: "to order Foundry Supplies from WILLIAM OLSEN, LTD., Hull."

SELECT YOUR MACHINE FROM THE LARGEST STOCK OF HIGH-CLASS SECONDHAND MOULDING MACHINES IN THE WORLD

Practical Advice Free

THE COLEMAN FOUNDRY EQUIPMENT Co. LTD
156, STRAND, LONDON, W.C.2.

PETER—WITH ONE EXCEPTION

With one exception Peter is an ordinary little fellow. Chubby, likeable, just five-and-a-half, full of life and fun and on occasions—be it admitted—of naughtiness.

Just now Peter's rather important, for this is his first term at school, and he's grappling with the intricacies of "A B C" and 'Twice-Two": difficult subjects to all men of five-and-a-half, but even more difficult in Peter's case because—bad luck—he's totally blind. That's his One Exception.

Peter learns reading, writing, and 'rithmetic through the medium of "Braille"—dull stuff compared with the coloured picture books of most five-and-a-halfs. However, he's a stout lad is Peter, and he's making great progress.

Would you like to know more about him? How, in spite of his "One Exception," he is being educated and, when older, technically trained and usefully employed.

There is a long waiting list of "Peters" throughout the British Isles, for whom training and accommodation must be provided in the immediate future.

Will you help with a donation or annual subscription? Any sum, large or small, will be gratefully received.

Here's a suggestion. Your eyesight is worth 3d. a year to you. Send Peter and his handicapped pals 3d. for every year you've had it. Now, please, in case it slips your memory. Good idea?

The Chairman,
SCHOOL FOR THE BLIND
(Founded 1838),
SWISS COTTAGE, LONDON, N.W.3